

RED ROCK PASS, IDAHO

MORE JULY 1 1926

IN A TOPOGRAPHIC SETTING OF WASTE-COVERED MOUNTAIN SLOPES AND WASTE-AND-SEDIMENT-FILLED INTER-MONTANE VALLEY, THERE STANDS A GROUP OF ROCK HILLS WITH LEDGES PROMINENT AND SOME WITH ALMOST VERTICAL CLIFFS. NEITHER UP NOR DOWN THE VALLEY, AND NOT ON EITHER SLOPE, ARE THERE ANY ROCK LEDGES IN VIEW. BUT THESE CLIFFED HILLS RISE 300 FEET AND MORE ABOVE THE OLD CHANNEL FLOOR.

SUCH IS THE CONTRAST AT RED ROCK PASS. FROM LOGAN NORTHWARD ALMOST TO POCATELLO, THIS GROUP OF CLIFFS AND KNOBS OF ROCK IS ALMOST THE ONLY EXPOSURE OF INDURATED ROCK.

THE LOCATION IS AT AND FOR A MILE NORTH OF SWAN LAKE. RED ROCK BLUFF IS ONE OF THE GROUP. IT IS ESSENTIALLY ON THE DIVIDE WHERE BONNEVILLE'S WATERS SPILLED NORTHWARD AND, ACCORDING TO GILBERT, CUT DOWN 375 FEET IN ALLUVIUM IN ABOUT 25 YEARS. DOES GILBERT DESCRIBE THE ROCK KNOBS AND HILLS? HE MUST HAVE HAD AN EXPLANATION FOR THEM, IF HE HELD THAT THE CUTTING WAS IN ALLUVIUM. AND AN EXPLANATION IS NOT EASY!

IT IS TRUE THAT RED ROCK BLUFF, ON THE WEST SIDE OF THE COL, SEEMS TO BE PARTLY BURIED IN WASTE FROM THE WASATCH RANGE TO THE WEST. IT IS TRUE THAT THE SCARPS OF THE OLD CHANNEL ALONG THE WEST SIDE, BOTH NORTH AND SOUTH OF THE ROCK BLUFF, ARE IN ALLUVIAL WASTE.

IT SEEMS PROBABLE THAT THESE KNOBS ARE ERODED REMNANTS OF ROCK HILLS WHICH WERE EROSIONAL FORMS BEFORE THE WASTE ACCUMULATED IN PRE-BONNEVILLE TIME. IT DOES NOT SEEM PROBABLE THAT THERE WAS A COMPLETE RIDGE OF ROCK OR BARRIER OF ROCK ACROSS CACHE VALLEY HERE WHEN BONNEVILLE TOPPED THE CREST AND SPILLED OVER TO THE SNAKE. IT HARDLY SEEMS LIKELY, FROM THE EVIDENCE SEEN FROM THE TOP OF RED ROCK BLUFF, THAT BONNEVILLE WATERS EXCAVATED THE PASS AT THIS PLACE ENTIRELY IN ROCK.

BUT, WHETHER OR NOT THE WHOLE CHANNEL HERE WAS ERODED IN ROCK, IT IS CLEAR THAT GREAT EROSION OF ROCK OCCURRED. THESE BEETLING CLIFFS ARE SO OUT OF HARMONY WITH EVERYTHING ELSE IN THE WHOLE REGION THAT THEY MUST BE DUE TO THE RIVER WHICH SPILLED OVER TO THE SNAKE.

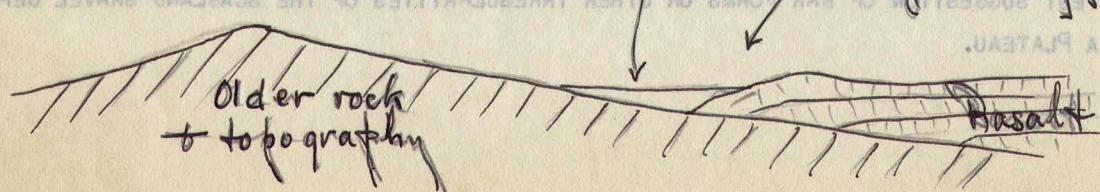
THE ROCK, AT LEAST IN RED ROCK BLUFF, IS A VOLCANIC FLOW AND BRECCIA. FAIRLY LARGE CAVES EXIST, APPARENTLY ORIGINALLY GAS CHAMBERS. NO COLUMNAR STRUCTURE. HENCE NONE OF THE DALLES CHANNEL TYPE OF EROSION AND NONE OF THE TYPICAL SCABLAND FORMS. BUT IN ALMOST EVERY OTHER WAY, THIS TRACT IN ITS SETTING OF FAIRLY MATURE SLOPES IS SCABLAND !

SNAKE RIVER LAVA PLAINS

JULY 2 1926

HIWAY FOLLOWS THE SOUTH SIDE OF SNAKE RIVER AND THE SOUTHERN MARGIN OF THE PLAINS FROM POCATELLO WESTWARD. HIGHLAND TO THE SOUTH CONSISTS OF OLDISH MOUNTAINS WITH PLENTY OF LONG DETRITAL OR EROSIONAL LOW SLOPES FLANKING THEM. OBVIOUSLY OLD WHEN THE FLOWS OF THE PLAINS OCCURRED. NO SUGGESTION OF ALIGNMENT OF FRONT OR OF SCARPS FACING THE PLAIN.

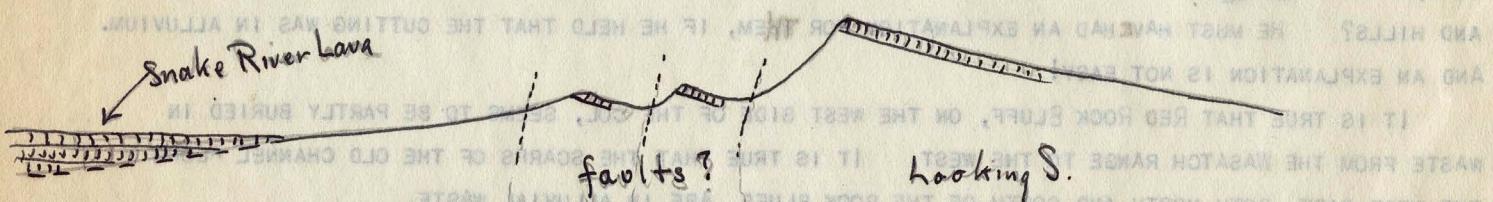
A GREAT DEAL OF YELLOWISH BROWN SILT, STRATIFIED, BETWEEN THE MTS AND THE BASALT CLIFFS ALONG THE RIVER. APPARENTLY POST-LAVA SILTING UP OF MARGINAL TRACTS WHICH THE STIFFENING FRONT OF THE FLOWS, MOVING SOUTHWARD TO THE LOWLAND MARGIN, DID NOT COVER. THESE SILTS ARE NOW DISSECTED NEAR THE CANYON OF THE SNAKE.



A BROAD EMBAYMENT AT YALE WITH A LARGE LATERAL FLOW APPARENTLY COMING FROM THE MTS TO THE S. NORTHWARD INTO THE LOWLAND. DISTINCT NORTHWARD SLOPE OF THE SURFACE OF THIS EMBAYMENT LAVA FILL.

NO GRAVEL SEEN IN THE POST-LAVA SILTS. BUT PLENTY OF GRAVEL ON TOP THE LAVA ABOUT POCATELLO AND AMERICAN FALLS. APPARENTLY FROM THE PORT NEUF, PERHAPS FROM BONNEVILLE DISCHARGE.

YES, THERE ARE SCARP FACES ALONG THIS SOUTH MARGIN OF THE LAVA PLAINS. A VERY DISTINCT ONE MARGINS THE WEST SIDE OF THE EMBAYMENT ABOVE NOTED. RIM ROCK OF THIS ESCARPMENT IS OF COLUMNAR LAVA, THO MOST OF THE FACE HAS NO LEDGES. LITTLE DEVELOPMENT OF VALLEYS AND RAVINES. DIP SLOPE IS DONG AND GENTLE TO THE WESTWARD. APPEARS TO BE AN INITIAL FAULT SCARP. IMPRESSION STRENGTHENED BY EXISTENCE OF WHAT APPEAR TO BE FAULT/SCARPS, FAULT SLICES, ON THE SCARP.



THE LAVA IN THE SCARP IS OLDER THAN THE SNAKE RIVER LAVAS

SOUTH OF DECLO IS A NOTABLE ALIGNMENT OF HIGH, RATHER STEEP SLOPES DESCENDING TO THE PLAIN TO THE NORTH. CONSIDERABLE DISSOCIATION OF THE SLOPE BUT FAR YOUNGER THAN ANY SLOPES NEARER POCATELLO, EXC. THE SCARP WEST OF THE YALE EMBAYMENT. AND NO SPURS HERE, PROJECTING OUT INTO THE PLAIN. FARTHER WEST AND SOUTHWEST, THE SAME MT. FRONT CONTINUES IN APPARENTLY THE SAME EXPRESSION BUT THE HIGHWAY IS TOO DISTANT <sup>FROM</sup> TO GET AN ADEQUATE VIEW.

BETWEEN BURLEY AND MURTAUGH, THE HIGHWAY CROSSES A HIGHER TRACT OF THE LAVA PLAIN, A TRACT OF VERY BROAD GENTLE SWELLS AND SLOPES AND POSSESSING SEVERAL BROAD DOME-LIKE HILLS, EACH ONE TWO OR THREE MILES IN DIAMETER. THESE APPARENTLY ARE LAVA CONES, SUCH AS RUSSELL DESCRIBED.

THE CANYON OF SNAKE RIVER AT SHOSHONE FALLS IS A MAGNIFICENT EXAMPLE OF THE DALLES TYPE OF RIVER CHANNEL. THE WIDTH OF CANYONED, CHANNELLED AND BUTTE-SPRINKLED CANYON SEEMS TO DEMAND A VOLUME OF WATER MUCH GREATER THAN THE SNAKE COULD EVER SUPPLY UNDER ORDINARY CLIMATIC CONDITIONS. YET THE CHARACTER OF THE SNAKE BOTH ABOVE AND BELOW THIS TRACT SHOWS THAT NO SPOKANE FLOOD EVER CAME DOWN THIS WATERWAY. IT IS SIMPLY HIGH GRADIENT, FLOOD WATERS AND COLUMNAR BASALTIC JOINTING THAT ARE RESPONSIBLE. THE <sup>lowest exposed</sup> ~~basal~~ FLOW IS NOT STRICTLY COLUMNAR; ITS STRUCTURAL PARTINGS ARE MUCH FARTHER APART. AND IT HAS NOT PRODUCED THE DALLES TYPE OF CHANNEL.

VALLEY OR CANYON OF SNAKE RIVER FROM THE ONSLEY (?) HIWAY BRIDGE DOWN TO GLENN'S FERRY HAS FINE GRAVEL TERRACES ABOUT A HUNDRED FEET ABOVE THE STREAM. THEY ARE CHIEFLY OF GRAVEL. SOME OF THE GRAVEL IS BOWLER-SIZE AND ALL OF IT IS FROM THE COLUMNAR BLOCKS OF THE BLACK, SCORIACEOUS SNAKE RIVER BASALT. SOME OF IT IS BOAD GRAVEL IN TEXTURE AND CONTAINS MUCH LIGHT-COLORED QTZITE DERIVED FROM THE MTS BEYOND THE LAVA PLAIN. THE TERRACES ALL BELONG TO ONE SERIES. THEY ARE FLAT-TOPT AND ON THE LANDWARD SIDE THE CHANGE TO THE WASTE-COVERED HIGHER LAND IS VERY GRADUAL. THERE ISN'T THE SLIGHTEST DEPARTURE OF THESE TERRACES FROM NORMAL FEATURES; THERE ISN'T THE SLIGHTEST SUGGESTION OF BAR FORMS OR OTHER IRREGULARITIES OF THE SCABLAND GRAVEL DEPOSITS OF THE COLUMBIA PLATEAU.

NOR WAS ANYTHING SEEN IN THE CANYON, SAVE ONLY SHOSHONE FALLS, WHICH SUGGESTS SCABLAND CHANNELS. JENKINS CAN NEVER GET ANY GREAT FLOOD THRU THE SNAKE RIVER CANYON IN SOUTHERN IDAHO.

IN THE VICINITY OF BLISS AND GLENN'S FERRY, THERE IS MUCH FINE-TEXTURED SEDIMENT BEHIND THE LAVA, AND APPARENTLY ALSO RISING IN PLATEAU-LIKE HILLS ABOVE IT. THE LAVA COVER NORTH OF BLISS AND KING HILL IS SO THIN THAT A GREAT DEAL HAS BEEN ERODED A FEW MILES NORTH OF THE RIVER. NEARER THE RIVER, THE LAVA IS THICKER AND THUS THE LARGEST STREAM OF THE REGION HAS DONE MUCH LESS LOCALLY THAN MINOR DRAINAGE OFF THE MOUNTAINS TO THE NORTH. DRA/INAGE LINES// DOCKING TREN

DRAINAGE LINES ON THE LAVA SURFACE SOUTH OF THE RIVER BETWEEN BURLEY AND TWIN FALLS APPARENTLY DETERMINED SOLELY BY THE LOWER PLACES AMONG THE IRREGULARLY PLACED LAVA CONES.

MANY AREAS ON THE BROAD, ALMOST UNDISSECTED PLAIN SURFACE BETWEEN GLENN'S FERRY AND BOISE ARE GRAVEL-STREWN WITH NON-BASALTIC AS WELL AS BASALTIC MATERIAL. APPARENTLY CARRIED OUT ON THE BASSALT PLAIN FROM THE MTS TO THE NORTH BEFORE BOISE RIVER AND CAMAS CREEK WERE TRENCHED

MOUNTAIN SLOPES NORTH OF THE PLAIN, FROM MT. HOME TO BOISE, ARE ALL OLD IN TERMS OF EROSION. NO NOTABLE SPURS SEEN PROJECTING OUT INTO THE PLAIN, BUT NO SCARPS OR OTHER STRUCTURAL SUGGESTIONS IN THE TOPOGR. IT SEEMS THAT A GREAT INTERMONTANE VALLEY WAS HERE READY FOR THE LAVA, LONG BEFORE THE LAVA FLOWS CAME. IN THIS BASIN THE PAYETTE SEDIMENTS OF THE REGION WERE DEPOSITED AND LATER ERODED BEFORE THE VOLCANIC ACTIVITY.

#### BOISE TO HORSESHOE BEND JULY 3 1926

OVER VERY INTRICATELY DISSECTED HIGH HILLS OR SUB-MOUNTAINS. THE SOUTHERN SLOPES SEEM TO BE ERODED IN THE PAYETTE SEDIMENTS BUT THE MAIN MASS IS OF GRANITE, PROBABLY THE IDAHO BATHOLITH. ROCK LEDGES IN STREAM BEDS AND ALONG LOWER SLOPES. SUMMITS NOT ATTAINED AND NO SKYLINE OBSERVED BUT PRESUMABLY, IF THERE EVER WAS A UNIFORM UPPER SURFACE, IT HAS ALL DISAPPEARED. PAYETTE (?) BEDS DIP GENTLY TOWARD THE PLAIN.

#### HORSESHOE BEND TO PAYETTE LAKES JULY 3 1926

VALLEY OF NORTH FORK PAYETTE RIVER IS A CANYON ALMOST ALL THE WAY FROM HORSESHOE BEND TO SMITHS FERRY. NARROW TERRACES 50 TO 100 FT ABOVE THE RIVER IN PLACES. RIVER HAS RIPPLES OVER BLDRS. ALL THE WAY. BRANCH LINE OF UNION PAC. R.R. AND HIWAY FOLLOW IT, BOTH WINDING, CLIMBING AND DESCENDING A GREAT DEAL. NOT ROOM FOR BOTH ON THE SAME SIDE OF THE VALLEY.

A VERY GREAT CONTRAST IN TOPOGR. HOWEVER, AS SMITHS FERRY IS APPROACHED. VALLEY ABRUPTLY WIDENS TO HALF A MILE OR MORE, WITH FLAT FLOOR, QUIET STREAM AND SPURLESS PARALLEL MT. WALLS / ON E AND W. HERE ARE THE TOWNS OF SMITHS FERRY, CASCADE, DONNELLY AND McCALL. AT THE LOWER PAYETTE LAKES, PERHAPS THE UPPER ONE ALSO. NORTHWARD TERMINATION OF VALLEY NOT SEEN. AS CLEARLY AS CAN BE; A FAULT VALLEY. IN PLACES, THE VALLEY IS INTERRUPTED BY GRANITE HILLS, PROBABLY MT. TOP REMNANTS OF THE SUNKEN BLOCK OR EDGES OF FRACTURED PORTIONS OF THE BLOCK. THE GLACIERS, DEEPLY CUTTED, REACHED NO FARTHER SOUTH. NO INDICATIONS IN THE VALLEY OR THE CANYON FARTHER SOUTH THAT ANY ESPECIALLY RAPID MELTING OCCURRED. WATER ARE YOUNG

NO ONE CAN SUGGESTIFLUTT PUT A P.P. ACROSS BOTH AGE GROUPS. NO ONE CAN CHALLENGE THIS STATEMENT ON

THE BASIS THAT THE CONTemporaneous AGE OF THE SALSAS ARE NOT DEMONSTRATED.

MC CALL TO WHITE BIRD JULY 4 1926

A DIVIDE OF GRANITE HILLS AND MTS SEPARATES THIS FAULT VALLEY AT MC CALL FROM ANOTHER OF character but larger SIMILAR PROPORTIONS TO THE WEST. PARALLEL TO EACH OTHER WESTERN ONE <sup>WAS</sup> ENTERED AT NEW MEADOWS. SOUTHERN EXTENT NOT SEEN. EXTENDS A FEW MILES NORTH OF NEW MEADOWS WHERE ITS UNRIPPLED STREAM (THE LITTLE SALMON) ENTERS A CANYON THENCE TO ITS JCT WTH THE SALMON AND BEYOND. VERY STEEP & GRASSED MTS FROM POLLOCK NORTH. HAVE NEVER SEEN MT SLOPES SO STEEP WITH SOIL, SAGE AND GRASS COVERING THEM. COLUMBIA BASALT APPEARS SOUTH OF POLLOCK AND CONSTITUTES THE MAIN MASS FROM RIGGINS NORTH. TILTED INTO MT. STRUCTURES BUT NOT CLOSELY FOLDED. SCHISTS AND THE WALLOWA WHITE AND BLUE-BLACK LIMESTONES BELOW THE BASALT NO CONTACT WITH THE BATHOLITH SEEN. FAR LESS EXPOSURES THAN IN THE WALLOWAS AND LESS OPPORTUNITY OF FINDING THEM FOR THE OUTCROPS ARE ONLY DOWN IN THE VALLEY BOTTOMS.

AT HORSESHOE BEND, A FEW MILES <sup>SOUTH</sup> OF THE WHITEBIRD, THERE IS A LARGE MESA IN THE MIDDLE OF THE BEND, COMPOSED OF OLD GRAVELS AND COMPLETELY ISOLATED FROM THE VALLEY WALLS. RIVER NOW SWINGS AROUND THE EAST SIDE OF IT. ALSO OTHER OLD ALLUVIAL GRAVES ON THE SLOPES. INDURATED IN PART, MUCH STAINED BY IRON, 200 FT OR SO ABOVE THE RIVER.

IN ADDITION TO THIS OLD VALLEY FILL, THERE ARE ROCK TERRACES WAY UP THE MT. SLOPES, IN SOME PLACES APPEARING TO BE HALF WAY UP. AND INTERRUPTED PROFILES OF THE SHOULDERS ARE PROMINENT. CLEARLY TWO CYCLES IN THE EROSIONAL HISTORY, A LATER AGGRADATIONAL EPISODE AND THE PRESENT ERO-  
TIONAL WORK.

WHITE BIRD TO LEVISTON JULY 4 1926

COLUMBIA BASALT THE ONLY BEDROCK FORMATION ENROUTE. A CLIMB 12 MI. LONG CARRIES ONE FROM THE SALMON RIVER VALLEY BOTTOM TO THE SUMMIT (4393) OF A NEARLY EW FOLD OF THE BASALT. LONG, SWEEPING PROFILES CHARACTERIZE THESE SLOPES, RAVINES AND GORGES ARE OF THE SIMPLEST CONSEQUENT TYPE, THE SKYLINE IS SCARCELY NOTCHED BY THEIR HEADWARD EROSION. THE YOUTHFULNESS OF THIS BIG ANTICLINE IS AS MARKED AS THAT OF THE BADGER ANTICLINE, THE SADDLE MT. ANTICLINE AND OTHERS IN WASHINGTON. THE UPLIFT HERE (BETW. WHITE BIRD AND GRANGEVILLE) WAS NOT AS GREAT AS THAT FARTHER SOUTH, AND THE LIMESTONE, SCHIST AND GRANITE DO NOT SHOW IN THE VALLEY BOTTOMS. THE PRESENCE OF THE TILTED BASALT FARTHER SOUTH SHOWS THE WHOLE MT. GROUP HERE TO BE OF THE SAME POST-COLUMBIA AGE.

WHAT OTHER MTS. ARE POST-COLUMBIA BASALT? THE WALLOWAS AND PROBABLY ALL THE BLUE MTS., THE MTS. OF THE JOHN DAY DRAINAGE, THE CASCADES BOTH IN OREGON (DESCHUTES VALLEY) AND IN WASHINGTON (FROM OREGON LINE TO WENATCHEE).

WHAT MTS. ARE PRE-COLUMBIA BASALT? THE COLVILLE MTS., THE NESPELEM, THE STRAWBERRY RANGE, THE BITTERROOTS, COEUR D'ALENES AND CABINETS.

WHAT BEARING DOES THIS HAVE ON THE PROBLEM OF PENEPLAIN CORRELATIONS? IT MEANS ONE THING CONCERNING THE IDAHO MTS., THAT THE SEVEN DEVILS AND THE MTS ALONG THE LOWER SALMON AND LOWER CLEAR-WATER ARE YOUNGER THAN MIocene AND THAT THE COEUR D'ALENES, BITTERROOTS, ETC, ARE PRE-MIOCENE. NO ONE CAN SUCCESSFULLY PUT A PP ACROSS BOTH AGE GROUPS. NO ONE CAN CHALLENGE THIS STATEMENT ON THE BASIS THAT THE CONTEMPORANEOUS AGE OF THE BASALTS AND THE CONTINUITY OF THE BASALTS ARE NOT YET DEMONSTRATED.

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THE SALMON RIVER, AFTER CROSSING THIS UPFOLD BETWEEN WHITE BIRD AND GRANGEVILLE, EMERGES IN THE PLATEAU COUNTRY WEST OF GRANGEVILLE. THE PLATEAU IS 3220 AT GRANGEVILLE. ITS UPLIFT MUST HAVE BEEN CONTEMPORANEOUS WITH THAT OF THE ANTICLINE. BOTH THE SALMON AND THE CLEARWATER HAVE YOUTHFUL CANYONS IN THE PLATEAU AND FEW <sup>PALE</sup> CANYONED TRIBUTARIES. MOST OF THE PLATEAU IS UNDISSECTED.

THERE IS ONLY A THIN LOESS DEPOSIT ON THIS PLATEAU AND ITS EXPRESSION IN QUITE UNLIKE THAT NORTH OF LEWISTON IN THE REGION OF DEEP, LOESSIAL SOILS. IT IS BROAD AND ROLLING IN ITS SLOPES BUT NOT HILLY. BASALT IS NEAR THE SURFACE ALMOST EVERYWHERE IF ONE MAY JUDGE FROM ROAD CUTS AND THE CAMAS PRAIRIE R.R. CUTS.

THE PECULIAR DRAINAGE PATTERN OF THE SNAKE, SALMON, CLEARWATER GROUP MAY BE THE RESULT OF FOLDING OF THE BASALT IN LARGE PART. BUT IF THIS BE TRUE, THE SALMON CANNOT BE HELD TO ~~CUT~~ CUT ACROSS THE ANTICLINE BETWEEN WHITE BIRD AND GRANGEVILLE. PERHAPS IT DOESNT. THE FOLD'S AXIAL CREST CERTAINLY IS LOWER WESTWARD FROM THE HIGHWAY CROSSING TO THE SALMON CANYON.

BUT ANOTHER DIFFICULTY LIES IN THE E-W ORIENTATION OF THIS FOLD AND THE LONG N-S SNAKE-SALMON DIVIDE WHICH, BY THE ABOVE HYPOTHESIS, SHOULD BE A FOLD IN THE BASALT. OBVIOUSLY, THE REGION NEEDS MORE STUDY.

THE PLATEAU FROM GRANGEVILLE TO LEWISTON LIES IN TWO GREAT LEVELS OR VERY GENTLE SLOPES, ONE FROM GRANGEVILLE TO WINCHESTER AT AN ALTITUDE NOT FAR FROM 3000 FEET AND ONE FROM CUL DE SAC TO THE SNAKE AND THE CLEARWATER, WEST AND NORTH RESPECTIVELY, AT AN ALTITUDE NOT FAR FROM 1700, PERHAPS AS HIGH AS 2000 NEAR THE UPPER EDGE. A STEEP SLOPE SEPARATES THEM, A MONOCLINAL SLOPE ALMOST AS STEEP AS THAT NORTH OF LEWISTON AND ONLY A LITTLE LESS HIGH. NO REVETMENT SPURS HOWEVER WERE SEEN, WHILE THEY ARE VERY CONSPICUOUS IN THE LEWISTON MONOCLE.

THE TOTAL AMOUNT OF EROSION BY THE SNAKE AND CLEARWATER NEAR THEIR JCT IS TO BE MEASURED FROM THIS 1700 FOOT PLATEAU AND AMTS TO ABOUT 1000 FT. THERE SEEMS TO BE NO MONOCLINAL DIP FROM THE 1700 PLATEAU DOWN TO OR TOWARD THE SNAKE OR CLEARWATER.

WHAT IS THE ORIENTATION OF THIS MONOCLE FROM 3000 TO 1700 LEVEL?

THE PLATEAU ABOUT GRANGEVILLE, NOTABLY BETWEEN COTTONWOOD AND FERNAND AND WESTWARD, IS INTERRUPTED BY GRANITE HILLS WHICH, THO LARGELY MANTLED BY WASTE, ARE KNOBBY AND IRREGULAR IN EXPRESSION AND EASILY DIFFERENTIATED FROM BASALT UPLIFTS EVEN THO ARRANGED, OR APPARENTLY ARRANGED, IN LINE. A SUBDOED SERRATE SKYLINE ALSO CHARACTERISTIC, ALSO IN CONTRAST WITH THE BASALT. DEEPLY DECAYED GRANITIC MATERIAL EXPOSED IN SOME ROAD CUTS, THO STILL IN PLACE AS THE JOINTS AND VEINS SHOW. ELSEWHERE, LEDGES OF GRANITE OUTCROP.

THESE ARE STEPTOES! THE IRREGULAR OLD TOPOGRAPHY, ELSEWHERE KNOWN TO HAVE EXISTED BEFORE THE FLOWS, WAS HERE ALSO. AND THE GRANITE BASEMENT IS NOT FAR BELOW. THEREFORE THE GRANITE MUST HAVE BEEN DEFORMED TO CONFIRM WITH THE GREAT FLEXURES THAT EXIST IN THE BASALT. GRANITE BASEMENT OF THE 3000 FT GRANGEVILLE PLATEAU WENT UP, SO DID GRANITE, QTZITE AND ARGILLITE BASEMENT OF THE STEPTOE, TEKO PLATEAU. OR THE GRANITE BASEMENT BENEATH THE LEWISTON SYNCLINE WENT DOWN. THE OLD, BURIED TOPOGRAPHY IS WARPED IN THE SAME TERMS AS THE BASALT.

AND SINCE THE BASALT NEVER OVERLAY THESE STEPTOES OF THE IDAHO-WASHINGTON REGION, THERE NEVER HAS BEEN ANY DEEP BURIAL OF THE GRANITE. ITS DEFORMATION OCCURRED BUT A FEW 1000 FT. AT THE MOST, FROM THE SURFACE. IS THIS EVIDENCE WORTH ANYTHING TO THE STRUCTURAL GEOLOGIST?

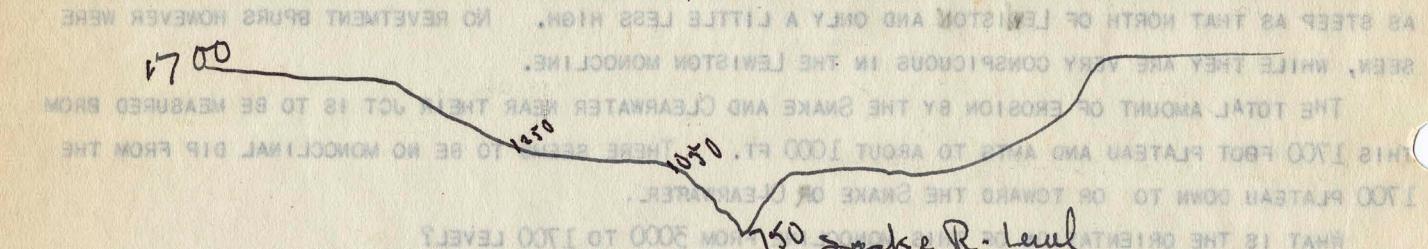
STREAM GRAVEL, OLD AND WEATHERED, OF A GREAT VARIETY OF ROCK, IS EXPOSED IN HIGHWAY CUTS ON THE GRANGEVILLE PLATEAU ABOUT MIDWAY BETWEEN THE CLEARWATER AND THE SALMON. IT MUST ANTEDATE THE UPLIFT FOR NO DRAINAGE TODAY COULD BRING IT HERE. IT MUST ANTEDATE THE PRESENT DRAINAGE LINES.

LOWER ASOTIN CREEK VALLEY JULY 5 1926

UP TO ABOUT 950 <sup>ft</sup> A.T. ~~IS~~ BLACK BASALTIC SAND, WITH STRATA AND LENSES OF BUFF SILT. SAND IS FORESET BEDDED AND LOCALLY DELTABEDDED, WITH DIP DOWN THE ASOTIN. SOME ASSOCIATED GRAVEL, ALL ~~ONE~~ BASALT. THIS ALTITUDE IS ABOUT THE SAME AS THE GRAVEL TERRACE ON THE EAST SIDE OF SNAKE RIVER AND BETWEEN THE LATITUDE OF CLARKSTON AND ASOTIN.

ABOVE 950, GRAVEL (ALL OF BASALT) IS EXPOSED IN MANY CUTS ALL THE WAY UP TO 1250<sup>ft</sup>. PLATEAU SUMMIT HERE IS ABOUT 1700. ABOVE 1250 ONLY SLOPE RUBBLE IS PRESENT, NO STREAM GRAVEL. A NOTABLE DEGREE OF DECOMPOSITION ~~IS~~ SHOWN IN SOME OF THE CUTS. IN OTHERS, THE GRAVEL IS FAIRLY FRESH, THO NOT "BRIGHT". APPARENTLY THIS IS A MATTER OF RECENT REMOVAL OF THE UPPER DECOMPOSED PART IN THOSE SECTIONS WHERE GRAVEL APPEARS FRESH. SOME OF THE GRAVEL IS COBBLY, EVEN BOULDERY.

A VERY STRIKING FEATURE OF THE PROFILE OF ASOTIN CREEK VALLEY NEAR THE MOUTH IS THE CANYON VALLEY, WITH ROCKY LEDGES, WITHIN A BROADER OLDER VALLEY. THE FLOOR OF THE BROAD VALLEY IS NOW ONLY A SUCCESSION OF SPURS, CAPPED WITH GRAVEL AND RANGING IN ALTITUDE FROM 1250 TO ABOUT 1050. ASOTIN CEMETERY LIES ON ONE OF THESE SPURS. THEIR SUMMITS SLOPE VALLEYWARD AND ANY ONE SPUR



SUMMIT MAY BE 100 FT LOWER AT THE TIP THAN AT THE BASE AGAINST THE HIGHER OLDER VALLEY SLOPES. THIS IS largely SLOPE INHERITED FROM THE OLDER VALLEY FLOOR, NOW DISSECTED, FOR THE GRAVEL-BASALT CONTACT ~~ALSO~~ IN THESE SPUR TOPS ALSO DESCENDS TOWARD THE MIDDLE OF THE VALLEY.

IN OTHER WORDS, NO OLD FLOODPLAIN LEVEL IS PRESERVED HERE. RATHER IS IT A SUCCESSION OF GRAVELS LEFT BY THE SLOW DEEPENING OF THE BROADENED VALLEY FOR THE 200 FT RANGE, OR MORE PROBABLY IS IT A RECORD OF AGGRADATION OF ABOUT 200 FT AFTER THE WIDENING WAS ATTAINED, AND BEFORE THE INNER VALLEY WAS CUT.

YET NEITHER EXPLANATION SEEMS QUITE SATISFACTORY.

THE FACT THAT ASOTIN CREEK DRAINS FROM A PLATEAU AREA ENTIRELY (AND ALWAYS HAS - AS THE 100% BASALTIC COMPOSITION OF ITS OLD GRAVELS PROVES) AND STILL SHARES IN THE HIGH-LEVEL GRAVELS, MAKES IT PERFECTLY CLEAR THAT THESE GRAVELS ARE GENETICALLY RELATED TO VALLEY DEVELOPMENT, NOT TO SOME EPISODE LIKE THE SPOKANE FLOOD. THE FLOOD WAS OF GLACIAL ORIGIN AND NO GLACIATION EVER OCCURRED UP THE ASOTIN.

THE FURTHER, THESE GRAVELS ARE OLD, WHILE THE SCABLAND GRAVELS ARE YOUNG AND FRESH.

NOR IS THERE ANY SUGGESTION IN THE CROSSBEDDED AND DELTABEDDED SAND AT 950 IN THE MOUTH OF ASOTIN CREEK VALLEY THAT IT WAS DEPOSITED BY ANY FLOOD IN THE SNAKE RIVER VALLEY BACKING UP THE ASOTIN.

LEWISTON, IDAHO JULY 6 1926

A LARGE GRAVEL DEPOSIT ON THE EAST SIDE OF SNAKE RIVER ABOUT TWO MILES BELOW ASOTIN. 100 FT. THICK, ALTITUDE OF TOP 1030 IT LIES ON THE INSIDE OF A CURVE IN THE RIVER AND IMMEDIATELY UPSTREAM, OPPOSITE ASOTIN, ARE CLIFFS OF BASALT CONSIDERABLY HIGHER THAN THE GRAVEL DEPOSIT.



THE DEPOSIT IS ABOUT A MILE IN LENGTH ALONG THE VALLEY.

GRAVEL RANGES FROM FINE TO COARSE AND INCLUDES COBBLE STRATA AND SCATTERED BLDRS 2 FT. OR A LITTLE MORE IN DIAMETER. IT IS FORESET BEDDED, IN PART WITH DIP EASTWARD TOWARD THE TRIBUTARY VALLEY WHICH ENTERS HERE. SUFFICIENT INDURATION TO HOLD CUTS IN OLD RAILROAD GRADE STILL ALMOST VERTICAL. FRESH IN APPEARANCE AND COLOR.

THE DEPOSIT HAS NOT A FLAT TOP AS A GRAVEL TERRACE SHOULD HAVE. NOR DOES IT HAVE THE STEEP RIVERWARD SLOPES WHICH THE GRAVEL DEPOSITS BENEATH LEWISTON AND CLARKSTON HAVE. IT BLOCKS THE MOUTH OF A SPRING-FED TRIBUTARY FROM THE EAST AND THIS TRIB. HAS ONLY LOW SILT TERRACES, NO FILL TO CORRESPOND TO THIS GRAVEL IN THE SNAKE.

THE ONLY CLEARLY EROSIONAL SLOPES ARE ALONG A PORTION OF THE EASTERN MARGIN WHERE THE TRIB. HAS CUT A GORGE NEARLY 100 FT DEEP IN THE GRAVEL-BASALT CONTACT AND THE BASALT IS CONSIDERABLY ROUGHENED HERE. THE RIVERWARD WESTERN SLOPE IS NOT TERRACED AND LOOKS AS THO IT WERE A DEPOSITIONAL, CONSTRUCTIONAL SLOPE, THO IT MAY BE EROSIONAL AFTER ALL. CONSTRUCTIONAL SLOPE CLEARLY ON THE EASTERN SLOPE OPP. THE TRIB MOUTH. THIS, WITH THE FORESET BEDDING, INDICATES THAT THE LOWER PART OF THE TRIB VALLEY WAS DAMMED, FLOODED, WHILE THE DEPOSIT WAS BEING MADE; THAT THE DEPOSIT IS A BAR! IT WAS MADE IN A RIVER AT LEAST 100 FT DEEP HERE, PERHAPS 300 FT DEEP (730=RIVER; 750 FROM 1030) IF VALLEY WAS THEN AS DEEP AS NOW.

ABSENCE OF SUCH A BAR AT THE MOUTH OF THE ASOTIN IS EXPLICABLE IN TERMS OF ITS LOCATION ON THE OUTSIDE OF THE CURVE IN THE RIVER.

GRAVEL IS 75% TO 80% NON-COLUMBIA BASALT.

HAVE WE HERE A SCABLAND BAR? WAS THERE A SPOKANE FLOOD IN SNAKE RIVER AS WELL?

OR IS THIS A DELTA REMNANT OF A SNAKE RIVER LAKE AT THE WALLULA GATEWAY PONDING? THE  $\frac{1}{4}$  CLARKSTON AND LEWISTON TERRACES ARE MUCH LOWER (LEWISTON 45 ABOVE MAIN ST OR ABT 800 FT.) AND THERE ARE THREE OR FOUR MILES WITHOUT GRAVEL, OR WITH VERY LITTLE GRAVEL, ON SAME SIDE OF THE RIVER BETWEEN THE DEPOSIT AND THE LEWISTON DELTA. NEVERTHELESS, THE TWO MIGHT BE REMNANTS OF ONE BIG GRAVEL FILL HERE, THE DESCENT FROM 1030 TO 800 IN 4 MI PLUS OR MINUS BEING THE GRADIENT BY THE ALLUVIAL FAN SLOPE OF THE DELTA TOP. THIS GRADIENT SEEMS IMPOSSIBLY HIGH, HOWEVER.

LOWER CLEARWATER VALLEY

VALLEY TRAVERSED FROM LEWISTON ALMOST TO OROFINO, WHICH IS 47 MI. FROM LEWISTON. UNLESS CERTAIN SLOPES ABOUT 5 MI. ABOVE LEWISTON ON SOUTH SIDE OF RIVER ARE GRAVEL DEPOSITS (WHICH IS QUESTIONABLE) THERE IS NO GRAVEL IN THIS VALLEY EXCEPT FOR LOW TERRACES. CERTAINLY THERE IS NO SUCH DEPOSIT AS THAT BETWEEN ASOTIN AND LEWISTON. THIS IS A VERY CURIOUS THING FOR THE VALLEY IS DEEP ENOUGH AND CAPACIOUS ENOUGH TO RECEIVE AND RETAIN SUCH DEPOSITS.

TRAVERSE WAS CARRIED FAR ENOUGH TO PASS THE RIPARIA DAM LEVEL IN THE CLEARWATER GRADE. ABSENCE OF GRAVEL MEANS FAILURE OF FLOOD TO OCCUR IN THE CLEARWATER VALLEY. THEN IF THE FLOOD WAS OF CLIMATIC CAUSATION, THE VALLEY GLACIERS OF THE CLEARWATER DRAINAGE MUST HAVE BEEN TOO SMALL TO HAVE PRODUCED ANY RECORDABLE EFFECT.

THE CLEARWATER VALLEY SHOWS MOST ADMIRABLY THE TWO CYCLES OF VALLEY DEVELOPMENT. NEAR LEWISTON, THE INNER VALLEY HAS ADVANCED SO FAR THAT THE RECORD OF THE OUTER IS PRETTY NEARLY OBLITERATED. BUT NEAR OROFINO, THERE IS MORE FARMING LAND ON THE BENCH THAN IN THE VALLEY BOTTOM.

THIS OLD FLOOR IS PRETTY CLOSE HERE TO HALF WAY BETWEEN THE BRINK OF THE PLATEAU AND THE BOTTOM OF THE VALLEY. THERE IS A VERTICAL RANGE IN ALTITUDE OF ITS REMNANTS THAT MAY AMOUNT TO 200 FEET. NOTHING LIKE THE TEXTBOOK DIAGRAMS OF A REJUVENATED STREAM VALLEY. THE OLD FLOOR IS CUT INTO HUNDREDS OF SPURS AND DIVIDES BETWEEN RAVINES AND GORGES OF THE SECOND CYCLE. THESE HAVE BEEN LOWERED DIFFERENT AMTS DURING THE SECOND CYCLE, IF INDEED, THEY EVER DID CONSTITUTE A LEVEL FLOOR.

BUT NO GRAVEL SEEN ANYWHERE ON THEM. ABSENCE MAY BE ONLY APPARENT, FOR THE ROAD CUTS ARE VERY SHALLOW AND NO OTHER CUTS ARE AVAILABLE. AND THE ASOTIN CREEK TERRACE SPURS WOULD APPEAR JUST AS GRAVELLESS, WERE IT NOT FOR THE RECENT GRADING OF THE ANATONE HIGHWAY.

THE STRUCTURAL VALLEY SO PROMINENT AT LEWISTON PRACTICALLY DISAPPEARS 20 OR 25 MILES EAST UP THE CLEARWATER. IT DISAPPEARS IN PART BY DECREASE IN DISPLACEMENT, THE VALLEY AS A STRUCTURAL AFFAIR VANISHING AS ITS FLOOR RISES EASTWARD IN PART ALSO PERHAPS, THE CLEARWATER FAILS TO COINCIDE WITH THE AXIAL LINE OF THE FOLD AND THEREFORE OBSERVATIONS MADE IN THE CANYON SHOW NOTHING OF THE FOLDED STRUCTURE. IF THE FOLDED STRUCTURE DIES OUT WESTWARD IN THE SAME FASHION, IT WILL CONSTITUTE AN INTERESTING STRUCTURAL PROBLEM.

*Portland River Valley shows no suggestion at its jct. with Clearwater that it carried any part of the Spokane Flood. But it did. See later seasons notes.*

LEWISTON, IDAHO JULY 7 1926

THE LEWISTON RESIDENTIAL SECTION IS BUILT ON A GRAVEL DELTA, TOP WHOSE FLAT RANGES FROM 50 TO 100 FEET OR MORE ABOVE MAIN ST. (750). NO TERRACES ON IT, SIMPLY A GENTLY SLOPING SURFACE. HIGHER PART IS NOT NEARER THE SNAKE OR THE CLEARWATER, A CURIOUS THING. DELTA BEDDING TO SHOW DEEP WATER AT TIME OF DEPOSITION IS PROMINENT IN SECTIONS WHERE STREETS ASCEND THE FRONT. A DEGREE OF INDURATION WHICH HOLDS THE EXCAVATED STEEP FACES. NO STAINING—GRAVEL LOOKS BRIGHT AND FRESH EXCEPT FOR LIMY COATINGS.

THE SAME TERRACE IN CLARKSTON. ALT. AT NORTHERN (LOWER) EDGE IS NOT MORE THAN 785 IT RISES SOUTHWARD, UP THE SNAKE, AT RATE OF 50 FT PER MILE TO AN UPPER LIMIT OF 900 FT AT. STRUCTURE SHOWN IN ITS SCARPS ALONG SNAKE RIVER.

LEWISTON ORCHARDS STAND ON THE LOWER PLATEAU TOP, ALTITUDE FROM 1400 TO 1700. NO GRAVEL OF ANY SORT SEEN UP HERE. BUT AT FOOT OF NORTHERN SLOPE, SOUTH OF LEWISTON RESIDENTIAL SECTION, IS A DISSECTED TERRACE OF STREAM GRAVEL. PIT EXPOSES 35 FT OR SO OF WELL-STRATIFIED, WELL-ROUNDED GRAVEL WITH A PREVAILING FERRUGINOUS TINT. TOTAL THICKNESS FROM BOTTOM OF PIT TO TOP OF TERRACE AT THE PIT IS 65 FT. BASALT, GRANITE, ETC, ARE DECAYED TO THE BOTTOM OF THE EXCAVATION. THERE IS NO PRODUCTION OF A CLAY OF DECOMPOSITION, LIKE THAT IN THE UPPER SATSOP FORMATION IN THE WILLAMETTE VALLEY, BUT THE WORKMEN BREAK THE PEBBLES FREQUENTLY IN THE WORKING FACE, EVEN THO THE INDURATION IS NOT PRONOUNCED.

COBBLES NOT RARE BUT BOULDERS ABSENT., EXCEPT FOR A LINE OF LARGE CLAY OR VOLCANIC ASH BLDRS NEAR THE TOP OF THE SECTION. CURRENT BEDDING NOT PROMINENT, DELTA BEDDING ABSENT. A GENTLE SOUTHWARD DIP, 3° OR SO, SEEMS TO BE THE CONSEQUENCE OF TILTING SINCE DEPOSITION. THE CURRENT BEDDING DIPS SOUTH.

THE GRAVEL IS 75-80% NON-BASALT. MUCH QTZITE AND GRANITE. ALTITUDE OF TERRACE TOP AT THE PIT IS 1020, PERHAPS 1050 FOR HIGHEST EDGE OF TERRACE AGAINST BASALT TO THE SOUTH.

DESPITE THE COINCIDENCE IN ALTITUDE WITH THE BAR-LIKE TERRACE NEAR ASOTIN, THE TWO GRAVELS ARE HARDLY THE SAME FOR ONE IS COMPOSED OF BRIGHT, FRESH GRAVEL AND IS UNBRODED BY ITS OWN SLOPE WASH, WHILE THE OTHER IS SO ERODED THAT ONLY PORTIONS OF THE FLAT TOP REMAIN, AND DECAY HAS GONE DEEP INTO THE GRAVEL.

FIVE MILES AND A HALF EAST OF LEWISTON (CENTER) ON SOUTHEAST SIDE OF CLEARWATER, ARE TALUS AND WASTE-COVERED BASALT SLOPES IN WHICH THERE IS AN ABUNDANCE OF MILKWHITE QUARTZ OF QTZITE PEBBLES. NO EXPOSURE. THEY ARE REWORKED IN THE SLOPE RUBBLE NOW. THERE IS ALSO HERE A FAIR REMNANT OF THE OLD VALLEY FLOOR AND ALMOST UNDOUBTEDLY THESE PEBBLES HAVE COME DOWN FROM THIS OLD VALLEY FLOOR. ACROSS THE CLEARWATER HERE IS A LARGE REMNANT, REMARKABLE FOR ITS EXTENT OF FLATTISH TOP. BOTH ARE 400 FT ABOVE THE RIVER, MORE THAN HALF WAY UP THE SOUTHERN WALL THO LESS THAN HALF THE HEIGHT OF THE MONOCLINAL UPLIFT TO THE NORTH. AND THE MONOCULAR SHOWED WHITE OR LIGHT-COLORED SEDIMENTS CAPPING THIS FLAT SPUR ON THE NORTH, WITH PLENTY OF WHITE COBBLES SCATTERED ON THE HILLSIDE. THE CHANCE FOR ERROR IN THIS OBSERVATION IS BUT SLIGHT. BASALT LEDGES AND TRICKLES ARE CONSPICUOUS IMMEDIATELY BELOW. THE GRAVEL OVER HERE MAY BE 50-75 FT THICK.

RE-EXAMINATION OF THE BAR-LIKE TERRACE NORTH OF ASOTIN ON THE IDAHO SIDE OF THE SNAKE. IT WAS LONG-RANGE OBSERVATION BUT IT SHOWED SOME THINGS BETTER THAN A CLOSE-UP. SEEN FROM THE ROAD TO ANATONE, ALT. ABOUT 1700 THE "BAR" FROM HERE IS SEEN TO BE SIMPLY AN OLD ERODED TERRACE ITS RIVERWARD SLOPES FURROWED WELL WITH SHALLOW BROAD RAVINES OF ITS OWN SLOPE WASH AND OF WASH FROM THE BASALT BLUFFS SOUTH OF THE BLOCKED VALLEY. SECONDARY TRIBUTARIES HAVE DEVELOPED, LEADING TO THE MAIN FURROWS. IT LOOKS OLD. NEXT TO THE BASALT BLUFFS, A WASH APRON HAS GROWN OUT ON THE TERRACE; ANOTHER SIGN OF AGE. THE ABSENCE OF A FLAT TOP NOW APPEARS DUE TO POST-TERRACE EROSION. AND THERE ARE GRAVEL DEPOSITS IN ROUNDED SHOULDERS ON THE WASHINGTON SIDE, AT THE SAME ALTITUDE AS, AND OPPOSITE, THE "BAR". IF THE EXPOSED GRAVELS IN THE ABANDONED RR CUT WERE ROTTEN AND STAINED, I WOULD UNHESITATINGLY CORRELATE IT WITH THE OLD GRAVEL DIRECTLY SOUTH OF LEWISTON. FOR THE ALTITUDE IS THE SAME AND THERE IS ESSENTIAL CONTINUITY OF THE TERRACE, A THING DENIED A FEW PARAGRAPHS BACK.

BUT WHETHER OR NOT OF THE SAME AGE, THEY ARE BOTH TOO OLD TOPOGRAPHICALLY TO BELONG IN THE SPOKANE EPOCH. THE ONLY POSSIBLE SPOKANE GRAVELS ABOUT THE JUNCTION OF THE SNAKE AND CLEARWATER RIVERS ARE THE LEWISTON AND CLARKSTON TERRACES OF DELTA-BEDDED SAND AND GRAVEL.

CLARKSTON TO ANATONE JULY 7 1926

THE PLATEAU IMMEDIATELY SOUTH OF ASOTIN HAS 1700 FOOT SUMMITS ON ITS SPURS AND 1900 ON ITS UNDISSECTED PORTIONS. THE RISE THENCE TO ANATONE IS VERY GRADUAL, THE ALTITUDE AT THAT VILLAGE BEING 3400+. FROM THIS VERY SMOOTH PLATEAU SURFACE CAN BE SEEN THE NOTABLE MONOCLINAL FLEXURE TO THE NORTH OF THE CLEARWATER AND THE SNAKE BELOW THE CLEARWATER'S JUNCTURE. ANOTHER NOTEABLE MONOCLINAL FLEXURE MAY BE SEEN TO THE EAST, RISING TO THE WINCHESTER AND GRANGEVILLE PLATEAU, AND A THIRD GREAT WARP TO THE WEST, A PART OF THE NORTHERN BASALTIC SPUR OF THE BLUE MTS. INTO WASHINGTON.

THE LEWISTON ORCHARDS (1400 N. margin) CONSTITUTE THE NORTHERNMOST margin OF THE NEARLY HORIZONTAL FLOWS OF THE PLATEAU HERE (EARLIER CALLED THE LOWER PLATEAU). BELOW THEIR BRINK IS THE ERODED PORTION OF THE GREAT VALLEY, WHERE SNAKE AND CLEARWATER JOIN.

SOUTHWARD FROM ANATONE (A LITTLE E. OF S.) STRETCHES THE PLANE SURFACE OF THE RISING PLATEAU, WITH A FEW MOUNTAINOUS GROUPS OF ELEVATIONS FAR IN THE DISTANCE RISING ABOVE IT. THIS IS NEAR THE JCT OF SNAKE AND SALMON AND MUST BE THE SOUTHERN LIMIT OF THE PLATEAU SURFACE IN THIS DISTRICT FOR BEYOND, TO THE SOUTH, ARE THE GREAT MOUNTAINOUS RIDGES ALREADY DESCRIBED BRIEFLY.

THIS PLATEAU SOUTH OF THE SNAKE AND CLEARWATER AND FROM GRANGEVILLE TO ANATONE IS TOTALLY DEVOID OF LOESSIAL HILLS. ITS SOIL IS THIN AND IN <sup>south</sup> PLACES, WHERE THERE HAS BEEN NO CONCENTRATION OF WASH, THE BASALT IS TOO NEAR THE SURFACE FOR PLOWING. SINCE THE PLATEAU ABOUT ANATONE OR GRANGEVILLE OR WINCHESTER IS OF THE SAME FORMATION AND THE SAME AGE AS THAT IN THE PALOUSE COUNTRY AND SINCE BOTH ARE ALIKE IN DEGREE AND AMOUNT OF EROSION AND CLIMATIC CONDITIONS WHICH WOULD DETERMINE RATE OF WEATHERING, IT FOLLOWS THAT THE FINE TEXTURED PALOUSE WHEAT SOIL IS NOT A PRODUCT OF DECOMPOSITION OF THE UNDERLYING BASALT.

LEWISTON AND CLARKSTON JULY 8 1926

NOTE THAT ONE OTHER UNEXPLAINED ITEM REMAINS CONCERNING THE "BAR" TERRACE. IT DOES BLOCK THE TRIB VALLEY FROM THE EAST AND THE TRIB STREAM IS NOW ESCAPING BY A NARROW DEFILE BETWEEN GRAVEL AND BASALT. THIS DEFILE IS CANYON-LIKE, IT IS YOUNG! AND THE UNFILLED TRIB VALLEY TELLS OF RAPID INCREASE IN DEPTH OF THE MAIN STREAM, AND OF A SHORT DURATION OF THE PONDING.

SINCE THE ALTITUDE HERE IS 1030, NOT FAR BELOW THE WALLULA GATEWAY PONDING, WHY NOT ASCRIBE THIS BAR FORM TO DAMMING OF THIS EPISODE AND CONSIDER IT BUILT ON AN OLDER TERRACE, ITSELF LARGELY UNMODIFIED BY THE PONDING ABOVE AND BELOW THE BAR?

THE LARGE REMNANT OF VALLEY FLOOR FIVE MILES EAST OF LEWISTON ON THE NORTH SIDE OF THE CLEARWATER, HAS A SUMMIT ALTITUDE OF 1100. THERE IS 100 FT OF GRAVEL HERE; WELL WORN, FAR-TRAVELED QTZITE, GRANITE AND OTHER CRYSTALLINES. NO EXPOSURES TO SHOW DEGREE OF DECOMPOSITION. IT LIES ON THE OLD VALLEY FLOOR REMNANT, HENCE MAY BE CONSIDERED AS BELONGING TO THAT EPISODE. BUT THE CLARKSTON ORCHARDS TERRACE AFFORDS DATA WHICH CLEAR UP THE MATTER OF OLD VALLEY GRAVELS.

CLARKSTON CITY TERRACE ENDS ABRUPTLY TO THE SOUTH AGAINST STEEPER SLOPES AT 950. THIS SEEKS

NW end of Clarkston terrace, where Walla Walla highway descends, shows good foreset bedding with downstream dip

TO BE THE UPPER LIMIT OF FRESH GRAVEL IN THE REGION, EXCEPT FOR THE BAR TERRACE. ABOVE THIS TERRACE IS THE CLARKSTON ORCHARDS TERRACE WHOSE SURFACE IS SOMEWHAT UNDULATORY BUT HOLDS CLOSELY TO 1100 FT. A.T. THE WESTERN PORTION OF THIS TERRACE HAS NO ORCHARDS AND IS EASILY VIEWED. IT IS MUCH DISSECTED BY BROAD, OPEN GULLIES AND IS COMPOSED OF AN OLD DECAYED STAINED GRAVEL IDENTICAL WITH THAT SOUTH OF LEWISTON AND NORTH OF LEWISTON ORCHARDS TERRACE. MOSTLY FOREIGN MATERIAL. THIS GRAVEL IS EXPOSED IN A PIT AT THE EXTREME SOUTHWEST END OF THE ORCHARD TRACTS. VALLEY FROM HERE NORTHWARD TO THE SNAKE IS CUT IN THE GRAVEL OR BETWEEN GRAVEL AND BASALT, AND SHOWS NO BASALT LEDGES OR RUBBLE. INSTEAD, ALL FRAGMENTS IN BOTTOM AND ON SLOPES ARE OF THE OLD GRAVEL WHICH IS CLEARLY MORE THAN 200 FEET THICK.

NOW THE DOWNWARD EXTENSION OF THIS OLD GRAVEL INTO THE LIMITS OF THE INNER VALLEY OF THE SECOND CYCLE, WHILE ITS SURFACE IS THAT OF THE GRAVEL 5 MI. EAST OF LEWISTON ON NORTH SIDE CLEAR-WATER (ON BASALT SPUR OF OLD VALLEY FLOOR) PROVES THAT BOTH VALLEYS HAD BEEN CUT BEFORE THE OLDEST GRAVEL OF THE REGION WAS DEPOSITED. SAME RELATIONSHIP AS AT HORSESHOE BEND ON THE SALMON.

THEREFORE THERE IS NO STREAM GRAVEL IDENTIFIED AS BELONGING TO THE OLD FLOOR. THE DIFFICULTY OF THE GREAT THICKNESS OF THIS SUPPOSED OLD FLOOR DEPOSIT IN ASOTIN CREEK VALLEY DISAPPEARS. THE ABSENCE OF ANY OLD FLOOR DEPOSITS UP THE CLEARWATER ABOVE LAPWAI IS NO LONGER A DIFFICULTY FOR THE OLD GRAVEL NEVER WAS DEPOSITED AS HIGH AS THEY STAND, THIS FAR UP THE CLEARWATER.

THE CONCEPTION NOW ADVOCATED IS THAT THE TWO CYCLES ARE RECORDED ONLY BY EROSIONAL FORMS, AND THAT THE AGGRADATIONAL EPISODE OF THE OLD GRAVEL OCCURRED SUBSEQUENT TO THE CUTTING OF THE INNER VALLEY, DURING WHICH THE INNER VALLEY WAS ENTIRELY FILLED AND THE LOWER ROCK TERRACE REMNANTS ABOUT LEWISTON, CLARKSTON AND ASOTIN WERE ALSO COVERED. THOSE FARTHER UP THE CLEARWATER WERE TOO HIGH. THEN RENEWED EROSION AND THE CLEANING OUT OF THE INNER VALLEY. THEN THE DEPOSITION OF THE LEWISTON AND CLARKSTON CITY DELTA TERRACES, THIS BY THE SNAKE ALONE. (Why by the Snake alone?)

NEAR SNAKE RIVER JCT. ARE SOME CHANGES IN THE COURSE OF THE SNAKE, ASCRIBED IN "SPOKANE FLOOD BEYOND CHANNELLED SCABLANDS" TO EROSIONAL WORK OF THE FLOOD. IN ONE OF THE ABANDONED LOOPS IS AN OLD GRAVEL, IDENTICAL, SO FAR AS I NOW RECALL, WITH THE OLD GRAVELS ABOUT LEWISTON AND CLARKSTON. WHY NOT EXTEND THIS OLD GRAVEL FILL DOWN THAT FAR AND HAVE THE RIVER IN BLEANING IT OUT SUBSEQUENTLY, HIT UPON THE LOWER SHOULDERS BURIED IN THE GRAVEL, BECOME ENTRENCHED AND STAY THERE?

LEWISTON TO DAYTON JULY 8 1926

A LARGE GRAVEL DEPOSIT IN SNAKE RIVER VALLEY AT SILCOTT IN A WIDER PLACE IN THE VERY HEAD OF THE CANYON WHICH LEADS OUT OF THE STRUCTURAL VALLEY. ITS SUMMIT IS ABOUT 850, ITS BASE 790. IT IS COMPOSED OF THE FRESH UNSTAINED GRAVEL, THE ONLY DIFFERENCE IN APPEARANCE BETWEEN IT AND PRESENT DAY STREAM GRAVEL BEING THE LIME COATINGS ON PARTS OF PEBBLES WHERE THEY HAVE BEEN IN CONTACT.

SURFACE IS NOT FLAT, NOR IS IT IRREGULAR BECAUSE OF SUBSEQUENT EROSION. IT IS NOT A TERRACE FOR IT IS SEPARATED FROM THE SOUTH WALL BY A WELL-MARKED CHANNEL OF THE SNAKE APPARENTLY NOT MORE THAN 10 OR 20 FEET ABOVE PRESENT DAY FLOOD LEVEL. ITS SURFACE IS HIGHER NEARER THE SNAKE AND THE WAY IT SLOPES DOWN TOWARD THE OLD CHANNEL STRONGLY SUGGESTS THE SCABLAND BARS. ITS MATERIAL IS FAR-TRAVELED AND WELL-ROUNDED COARSE GRAVEL. NO STRUCTURE SHOWN THE ALTITUDE AND CHARACTER INDICATE THAT IT IS A PART OF THE LEWISTON AND CLARKSTON DELTA TERRACE. IF SO, THE ORIGINAL LENGTH OF THE DEPOSIT MUST HAVE EXCEEDED 10 MILES, EVEN IF IT NEVER REACHED BELOW SILCOTT

VICINITY OF STARBUCK AND GRANGE CITY, JULY 9 1926  
in field  
BLDR OF GRANITE, 3 FT IN MAX. DIA., ALONG HIGHWAY 5 1/2 UP TUCANNON ABOVE STARBUCK. ASSOCIATED WITH NUMEROUS FRAGMENTS OF GRANITE OF DIFFERENT KINDS, QZITE, LIMESTONE, DIORITE. ONE GREEN STONE STRIATED. ALTITUDE 800 A.T.

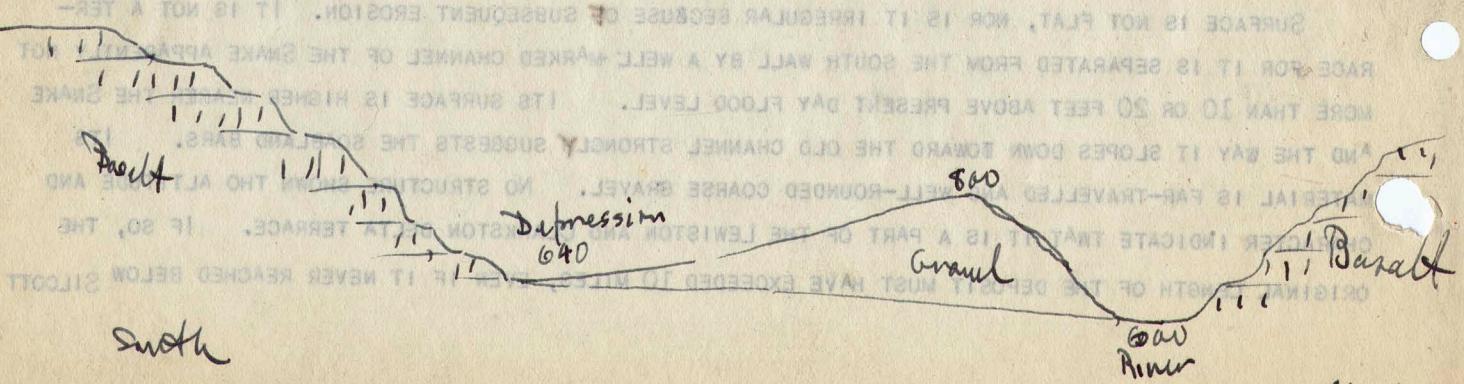
THE SCABLAND FLOOD WONDERFULLY SET FORTH IN THE GENERAL VICINITY OF JUNCTION OF SNAKE AND TUCANNON. IT SEEMS TO ME THAT NEVER BEFORE HAS ITS MAGNITUDE APPEALED SO STRONGLY, OR BEEN SO STRIKINGLY SET FORTH.

THE FARDEST UP-VALLEY RECORD OF THE FLOOD, IN TUCANNON VALLEY, APPARENTLY LIES 2 MI. SOUTH OF STARBUCK ON POMEROY ROAD WHERE THE COMMON PALE BUFF VALLEY SILTS, OCCURRING IN TERRACES, ARE OVERLAIN BY A FEW FEET OF BLACK SAND AND FINE GRAVEL, CONTAINING A FEW FOREIGN PEBBLES AND CURRENT BEDDED UP THE VALLEY. ALT. 700. THE ONLY OTHER SUGGESTION FARTHER UP THE VALLEY IS THE SILT ITSELF. IT IS STRATIFIED AND CONTAINS LENSES AND STRATA OF BASALTIC RUBBLES IN SOME CUTS. IT MIGHT BE A PRODUCT OF PONDING OF THE TUCANNON. See notes for July 17 1926?

AT POWERS STATION, ABT 2 MILES NORTH OF STARBUCK, IS A PROMINENT GRAVEL TERRACE ON THE EAST SIDE OF THE VALLEY. ITS FLAT TOP IS 865 AT. ITS VALLEY SLOPES ARE 26°. IT IS BUT LITTLE GULLIED BY ITS OWN RUNOFF. ITS GRAVEL IS 95% BASALT, FROM 7 OR 8 PEBBLE COUNTS OF 100 PEBBLES EACH. THE BASALT PEBBLES ARE ANGULAR OR SUBANGULAR, THE NON-BASALT PEBBLES ARE WELL-ROUNDED. IT IS VERY STRIKING; THIS DIFF. IN AMT OF WEAR. STRUCTURE SHOWS VIGOROUS BUT SHIFTING CURRENTS. FORESET BEDS IN STRATA 10-15 FT THICK ARE SEPARATED BY 3-5 FT BEDS OF SILT AND FINE SAND NEARLY HORIZONTALLY BEDDED. THIS IS REPEATED. THERE ARE NO LONG FORESETS SHOW DIPPING DOWN THIS EAST WALL OF THE VALLEY. THE FINELY BEDDED HORIZONTAL STRATA SEEM TO INDICATE A RELATIVELY SLOW AGGRADATION AND PRESENCE OF RELATIVELY SHALLOW WATER DURING ACCUMULATION. THIS DOES NOT AGREE WITH THE CONCEPTION OF ABRUPT BEGINNING OF THE FLOOD, FOR IT DEMANDS TIME FOR SETTLING OF THE VERY FINE SAND AND THE SILT BEFORE THE NEXT OVERLYING FORESET BEDDED GRAVEL WAS DEPOSITED. THE LITTLE-WORN CHARACTER OF THE BASALT PEBBLES, HOWEVER, TESTIFIES TO THE RAPIDITY OF DEPOSITION AND THE SHORT DISTANCE OF TRAVEL.

THERE IS NO TERRACE ON THE WEST SIDE OF THE VALLEY HERE TO BE CORRELATED WITH THE POWERS TERRACE. BUT FORESET BEDDED SAND AND FINE GRAVEL ON THE VALLEY SLOPE WEST OF STARBUCK TESTIFY TO A ONCE COMPLETE FILLING UP TO THAT LEVEL (NOT MORE THAN 750).

THE VALLEY OF SNAKE RIVER BETWEEN GRANGE CITY AND PERRY IS FULL OF AMAZING THINGS. THERE IS A GREAT GRAVEL FILL IN THE VALLEY 200 FT THICK. ALTITUDE OF TOP 800 AT. RIVER ON ROCK AT THE NORTH BASE, ALT. 600 AT. RELIEF OF THE ORIGINAL SURFACE OF THE DEPOSIT IS AT LEAST AS GREAT AS 160 FT. AND ONE DEPRESSION ENCLOSED AT FOOT OF BASALT BLUFFS ON SOUTH SIDE OF VALLEY AND THE DEPOSIT, THAT MUST HAVE BEEN WALLED AROUND AT LEAST 50 FEET HIGH AT ITS LOWEST RIM. SURFACE IN GENERAL SLOPES FRM THE SOUTH WALL OF THE SNAKE CHANNEL, WHERE IT IS HIGHEST, DOWN TO THE FOOT OF THE SOUTH BASALT BLUFF.



SNAKE RIVER VALLEY WAS AS DEEP IN THE ROCK AS NOW WHEN THIS GRAVEL CAME TO REST. THE GRAVEL MUST HAVE BEEN IN THE FORM OF A HUGE MID-VALLEY BAR OR THE SNAKE NEVER COULD HAVE TAKEN ITS PRESENT COURSE ALONG THE NORTHERN MARGIN.

ABSENCE OF A SURFACE FLAT MEANS SUBFLUVIAL SLOPES, THEREFORE A RIVER DEEP ENOUGH TO COVER, AND WITH CURRENT VIGOROUS ENOUGH TO MODEL, THE SURFACE AS IT NOW IS.

FARTHER UP THE SNAKE CAN BE SEEN ANOTHER PORTION OF THE GRAVEL FILL, THIS ON THE NORTH SIDE OF THE RIVER AND SLOPING UP ALL THE WAY TO END AGAINST SCABBY BLUFFS. THIS IS PROBABLY THE RIPARIA DELTA TOP. RIVER FLOWS ON SOUTH SIDE, WITH BASALT CLIFFS ON ITS SOUTHERN SIDE.

BUT NO RIPARIA DAM DELTA AS SUCH EVER EXISTED. IT IS ALL A PART OF A TREMENDOUS FILL WHOSE SURFACE WAS ALL OR LARGEY UNDER WATER AND THE "250 FT. ABOVE RIPARIA" IS MERELY ONE ALTITUDE OF A PARTICULARLY PLANE TRACT IN THE WHOLE IRREGULAR DEPOSIT OF THE ENORMOUS PALOUSE TORRENT.

NOR IS THE 800 FT. ALT IN MID-VALLEY THE UPPER LIMIT OF THE FLOOD. GRAVEL DEPOSITS WHICH COMPLETELY MASK THE BASALT, COVER THE SOUTHERN WALL OF THE SNAKE ABOUT 1-2 MILES EAST OF PERRY BRIDGE. ALTITUDE 1000 PLUS OR MINUS. AND THE WATER WHICH CARRIED IT HERE SWEEPED UP OVER THIS LOWER PLACE IN THE BLUFF AND THEN WESTWARD TO RE-ENTER THE SNAKE A FEW MILES FARTHER DOWN. EASILY A SQUARE MILE OF UNDULATING SURFACE OF THE GRAVEL. NO PLANE IN HERE, NO EVIDENCE THAT THIS WAS THE UPPER SURFACE. SCABLAND EXTENDS SOMEWHAT HIGHER BUT IS WEAK. DOUBTLESS THE ONLY SIGNIFICANT "DAM" OR LEVEL OF THE SPOKANE FLOOD WAS THE WALLULA GATEWAY PONING. IT MAY WELL BE THAT THE VALLEY GRAVEL WAS DEPOSITED A LITTLE LATER THAN THE MAXIMUM FLOODING. BUT IT MAY ALSO HAVE BEEN DEPOSITED UNDER 200 FT. OF WATER.

SCABLAND OF SNAKE BLUFFS HERE IS GOOD. WHOLLY UNLIKE ANYTHING ABOUT LEWISTON AND CLARKSBURG. BUT QUITE INCONSEQUENTIAL WHEN COMPARED WITH THE MAGNIFICENT DISPLAY SEEN UP THE PALOUSE FROM THIS SIDE. (S.SIDE). THE MID-CHANNEL BUTTE REFERRED TO IN PREVIOUS YEARS IS CLEARLY MORE THAN 400 FEET HIGH AND THE ABANDONED CHANNEL ON THE WEST OF THE ONE CARRYING THE PALOUSE RIVER IS 200 FT. DEEP.

IN SNAKE VALLEY, AS IN TUCANNON, GRAVEL IS VERY LARGEY SUBANGULAR BASALT. BEAUTIFUL TERRACE-LIKE DEPOSITS OF GRAVEL HAVE BEEN SPILLED OUT BETWEEN HEADLANDS OR ROCK KNOBS INTO THE SNAKE FROM THE PALOUSE SCABLANDS EAST OF THE PALOUSE RIVER PRESENT CANYON. THEY LIE AT DIFFERENT ALTITUDES, HAVE FAIRLY PLANE SURFACES AND VERY STEEP FRONTAL SLOPES. THE ALTITUDE OF THEIR PLANE TOPS MEANS NOTHING AS TO THE ALTITUDE OF THE WATER SURFACE DURING THEIR AGGRADATION, EXCEPT THAT THE WATER COVERED ALL OF THEM. THEY ARE ALL SUBFLUVIAL.

CENTRAL FERRY JULY 10 1926

A WELL-DEVELOPED TERRACE ALONG THE SNAKE IN THIS PART OF THE VALLEY. VALLEY IS A MILE WIDE AT THE BRIDGE AND MOST OF THIS IS TERRACE. GOOD SECTIONS SHOWING WELL-WORN PEBBLES AND COBBLES BROKEN BEYOND THE LIMITS OF THE COLUMBIA PLATEAU. THE 90-95% PERCENTAGE OF BASALT TO NON-BASALT OF THE SCABLAND GRAVELS SHOULD BE REVERSED HERE. THERE ISN'T MORE THAN 10% COLUMBIA BASALT IF THERE IS THAT MUCH. IN THIS GRAVEL AT CENTRAL FERRY IT IS DIFFICULT TO FIND ANY PEBBLE THAT IS NOT WELL WORN. THE CONCLUSIONS ARE OBVIOUS.

TERRACE TOP AT NORTH END OF BRIDGE IS ABOUT 60 FEET ABOVE SNAKE RIVER HIGH WATER. IT IS NOT FLAT; IT VARIES UP AND DOWN THE RIVER AS SHOWN IN HEIGHT OF THE TERRACE SCARP AND IT VARIES ALONG CONTACT WITH THE BASALT VALLEY WALLS TO THE NORTH BECAUSE OF THE GROWTH OF BROAD LOW ALLUVIAL FANS OUT ON IT IN PLACES.

TWO OTHER CONSIDERABLE TERRACE REMNANTS OF THE SAME FILL, BOTH ON SOUTH SIDE OF RIVER, INSIDE OF A CURVE AS IS THIS AT THE BRIDGE, BOTH SAME ALTITUDE AS BRIDGE, BOTH WITH SLIGHT VARIATIONS IN HEIGHT OF SCARP AND BOTH WITH ALLUVIAL FANS BUILT OUT ON THEM, THO FANS AND TERRACES ARE NOW TRENCHED BY RAVINES FED FROM THE HILLS. CERTAINLY THEY ARE PARTS OF THE SAME FILL. CERTAINLY THEY BELONG TO THE SILCOTT AND THE LEWISTON AND CLARKSTON TERRACE DEPOSIT.

WHAT IS THE RELATIVE AGE OF THESE TERRACES AND THE SCABLAND GRAVELS? THERE ARE NO SCABBY FACES OF BASALT BLUFFS HERE, THE CLIFFS ACROSS THE RIVER FROM THE TERRACE SCARPS (WHICH MUST HAVE BEEN SUBJECT TO RIVER SCOUR DURING ON THEIR LOWER SLOPES DURING REMOVAL OF THE TERRACE GRAVEL) SELDOM SHOW FRESH SCARPS. LEDGES ARE SUBDUED, TALUS IS LONG AND SODDED. THESE DIFFERENCES CLIFFS ARE FAR OLDER THAN THOSE WHICH FACE THE SCABLAND TRACTS.

SO ALSO THE ALLUVIAL FANS ON THE TERRACE TOPS TELL OF GREATER AGE OF THE TERRACE GRAVEL DEPOSIT. THERE ISN'T MUCH DISSECTION OF THESE TERRACE FORMS, SAVE BY STREAM WAYS ACROSS THEM FROM THE HILLS AND BY THE SNAKE ITSELF. BUT THE SNAKE CANYON THRU THE GREAT GRAVEL FILL BETWEEN GRANGE CITY AND PERRY IS VERY NARROW, WHILE THE SNAKE'S COURSE THRU THIS CENTRAL FERRY TERRACE GRAVEL IS WIDE. DEPRESSIONS IN THE SCABLAND BARS ARE UNFILLED. HAD SLOPE WASH FROM THE HIGHER LANS OR HIGHER PORTIONS OF THE GRAVEL DEPOSITS THEMSELVES OCCURRED TO THE EXTEND THAT IS RECORDED BY THE LOW ALL. FANS ON THE CENTRAL FERRY TERRACE, <sup>(the depressions)</sup> THEY WOULD HAVE DISAPPEARED.

THE LEWISTON-CLARKSTON TERRACE, THE SILCOTT TERRACE AND THE CENTRAL FERRY TERRACE ALL ARE PARTS OF ONE VALLEY FILL, A FILL THAT TOOK A LONG TIME TO CONSUMMATE, A FILL THAT DEVELOPED SO SLOWLY THAT NORMAL CONDITIONS OF MT. EROSION AND PEBBLE WEAR SUFFICIENT TO SUPPLY IT, A FILL THAT WAS CAUSED BY REGIONAL RELATIONS OF GRADIENT AND SUPPLY.

THE SCABLAND GRAVEL, ON THE OTHER HAND, WAS NOT CONFINED TO THE VALLEYS, IT SPREAD BACK IN TRIBUTARIES, IT OVERFLOWED THE LOWER PARTS OF THE PLATEAU ADJOINING THE SNAKE, IT WAS DEPOSITED WITH A SURFACE RELIEF OF 140 FEET WITHIN A MILE AND THIS ACROSS, NOT ALONG, THE VALLEY, IT WAS DERIVED FROM THE WASHINGTON PLATEAU VERY RAPIDLY AND IS VERY LITTLE WORN, IT RECEIVED SOME OF THE GRAVEL FROM THESE OLDER SNAKE RIVER TERRACES AND THUS HAS 5% OR SO OF WELLWORN FOREIGN DEBRIS, ITS MARGINING CLIFFS ARE YOUNG, IT HAS NO ALLUVIAL FANS BUILT OUT ON IT.

THE TWO ARE FAR DIFFERENT IN AGE AND IN CONDITIONS OF ORIGIN. THE SNAKE AVE RIPARIA NEVER HAD A SCABLAND FLOOD.

ADDENDA— FORESET BEDDING IN CENTRAL FERRY SECTIONS IS PRESENT BUT IT IS NOT OF THE DELTA TYPE, EACH GROUP OF FORESETS APPARENTLY RECORDING SIMPLY A LOCAL POOL DURING THE AGGRADATION. SOME FORESETS DIP UPSTREAM BUT NO STRIKINGLY LARGE % DOES, AS MY EARLIER NOTES DESCRIBE FOR THE SNAKE RIVER TERRACES BETWEEN RIPARIA AND LEWISTON.

IN THIS GRAVEL AT CENTRAL FERRY IT IS DIFFICULT TO FIND ANY REVERSE THAT BASED ON THE SCABLAND GRAVEL SHOULD BE REVERSED. THERE ISN'T MORE THAN 10 FT. COLLECTED GRAVELS.

IF THERE IS 10 FT. GRAVEL, THE CONCLUSIONS ARE DRAWN.

VICINITY OF PERRY SOUTH OF THE SNAKE

JULY 10 1926

THE SPOKANE FLOOD WHICH SWEEPED OVER THE PALOUSE-SNAKE DIVIDE (HOOPERS TO PERRY) RAN UP INTO THE LOWER PART OF A LARGE TRIB. FROM THE SOUTH (PROBABLY FIELDS GULCH OF WALLAWALLA MAP) AND APPARENTLY THEN RAN WESTWARD OVER THE WEST WALL BETWEEN THIS TRIB VALLEY AND THE SNAKE. THE SCOURING OF BASALT CLIFFS IS VERY MARKED FOR MORE THAN A MILE BACK FROM THE SNAKE. THE RATHER CAPACIOUS TRIB. VALLEY HAS HUGE GRAVEL DEPOSITS IN IT, LYING TO THE LEE (SOUTH) OF THE BASALT EMINENCES, BEING HIGHEST AGAINST THEM AND SLOPING SOUTHWARD AWAY FROM THE SNAKE. THESE PROBABLY ARE 1000 FT AT AND THE SCOURING BASALT FULLY 100 FT HIGHER. ESTIMATE ON HEIGHT SECURED BY LEVELLING FROM STATION WHOSE ALTITUDE BY ANEROID WAS 1000.

THIS TRACT LIES JUST A FEW MILES NORTH OF THE WALLA WALLA SHEET, AND ITS CONTINUATION A FEW MILES DOWN STREAM BRINGS IT TO THE SNAKE RIVER JCT. DISTRICT, ALREADY DESCRIBED IN "SPOKANE FLOOD BEYOND CHAN. SCABLANDS". THIS TRACT IS IDENTICAL IN EVERY PARTICULAR BUT UNFORTUNATELY IS NOT YET MAPPED. THE ADDITIONAL DATA SUBSTANTIATE IN EVERY PARTICULAR ALL THE INTERPRETATIONS OF MY EARLIER WORK.

FROM HILLS ON EITHER SIDE OF EUREKA FLAT AT THE NORTH END, A MILE OR SO NORTH OF PLEASANT VIEW STATION, A MOST INSTRUCTIVE PANORAMA NORTHWARD CAN BE OBTAINED. ONE CAN SEE FAR NORTH OF THE SNAKE, AS FAR AS THE LOESSIAL HILL GROUPS NORTH OF HOOPER. THE LOESSIAL HILLS WEST OF THE PALOUSE SCABLAND TRACT AND THEIR STEEP AND REMARKABLY ALIGNED SCARPS ARE VISIBLE, THE SCABLAND SHOWS BLUE-BLACK OR VIOLET BLACK THRU THE DESERT HAZE, THE ISOLATED LOESSIAL HILLS (RELICT HILLS) OF THE EAST SIDE OF THE PALOUSE SCABLAND, AND THE PALOUSE LOESSIAL HILLS EAST BEYOND ALL SCABLAND. EVEN THE LARGE TRACT OF PALOUSE HILLS NORTH OF THE PALOUSE AND BETWEEN COW CREEK AND ROCK CREEK CAN BE DISCERNED. THE SCABBY LEDGES OF THE UPPER WALLS OF THE SNAKE AND BACK FROM THE EDGES ARE CONSPICUOUS. THERE APPEARS TO BE A GROUP OF LOESSIAL HILLS WEST OF THE PALOUSE CANYON, ALMOST ON THE BRINK OF THE SNAKE, WHICH HAVE BEEN CUT THRU IN SEVERAL PLACES BY THE SPREADING FLOOD. PROBABLY THIS IS ON MY MAP. <sup>Only</sup> AN AEROPLANE VIEW <sup>ALONE</sup> WOULD BE BETTER THAN THIS. THE ENSEMBLE IS CONVINCING, ABSOLUTELY CONVINCING. *Yea! It showed the giant ripples!*

THE TERRACE NORTH OF GRANGE CITY JCT HAS EXCELLENT LONG FORESETS, AS SEEN FROM THE SOUTH SIDE OF THE RIVER. BUT THESE ARE NOT CONTINUOUS. THERE ARE PLACES WHERE THE GRAVEL BEDDING IS ONLY SLIGHTLY INCLINED AND PLACES WHERE LOW PLACES LEFT IN THE ACCUMULATING GRAVEL WERE FILLED SEVERAL FEET DEEP WITH PALE BROWN SILT. SUCH SETTLING REQUIRED TIME, IT COULD NOT HAVE OCCURRED AS RAPIDLY AS THE GRAVEL COULD HAVE BEEN DEPOSITED. SOMEHOW, MORE TIME FOR THE DEPOSITION MUST BE SECURED. YET IF THE UPPER LIMIT OF THE GREAT FLOOD WAS MAINTAINED ONLY BECAUSE THE WALLULA GATEWAY WAS TOO NARROW FOR ADEQUATE ESCAPE, A VERY BRIEF TIME ONLY CAN BE ALLOWED.

THE CONTRAST IN CANYON WALLS ON THE SOUTH SIDE OF THE SNAKE NEAR RIPRIA IS MARKED. ABOVE THE UPPER END OF THE "DELTA" THE WALLS ARE TALUS-COVERED FROM TOP TO BOTTOM EXCEPT FOR A FEW LEDGES. BUT DOWN STREAM, ALONG THE SOUTH SIDE, THE MARKED SCABLAND FEATURES APPEAR ABRUPTLY. GRANITE ERRATICS IN PATAHA CREEK VALLEY ALONG HIWAY AT 1250 AND 1190.

DATA ON STRUCTURE OF THE COLUMBIA BASALT.

AT LEAST TWO LONG SPURS EXTEND NORTHWARD FROM THE BLUE MTS AND DIE AWAY IN THE GENERAL LEVEL OF THE PLATEAU. EACH IS UNDOUBTEDLY A WARP, ANTICLINAL IN NATURE. THE SURFACE OF THE WESTERN ONE DESCENDS FROM 4000 FT AT A POINT NEARLY WEST OF PEOLA TO ABOUT 1800 FT AT POMEROY (SUMMITS).

CONSIDERED, NOT STREAM VALLEYS). THRU POMEROY FROM EAST TO WEST THE SUMMIT LEVELS MAKE A BROAD SHALLOW TRACT FROM DELANEY WELL TOWARD SILCOTT. THIS SHOULD BE CONSIDERED THE WESTWARD CONTINUATION OF THE LEWISTON STRUCTURAL VALLEY.

NORTH OF THIS TRACT OF LOWER SUMMIT LEVELS EXTENDS AN E-W BELT OF HIGHER LEVELS, 2000 FT HIGH NORTH OF DELANEY. THIS IS AN UPWARP WHICH ORIGINALLY DETERMINED THE SEPARATION OF PATAHA CREEK AND SNAKE RIVER.

THE WARPINGS OF THE BASALT SURFACE ARE NOT MARKED. NO MEASUREMENTS ON BIPPING FLOWS CAN BE MADE, THE DIP IS TOO GENTLE. BUT EROSION IS WHOLLY INADEQUATE TO EXPLAIN THESE BROAD, BENTLY SLOPED FEATURES. AND OF COURSE THE LEWISTON MONOCLINE AND MANY OTHER FOLDS SHOW THEIR NATURE TO BE DIASTROPHIC.

THE DRAINAGE PATTERN IN LARGE PART IS DETERMINED BY THE STRUCTURE THO SUCH THINGS AS THE SNAKE'S V ABRUPT ENTRANCE INTO THE UPLIFTED SIDE OF THE MONOCLINE MUST BE CONSIDERED AS ANTECEDENT.

#### THE DISTRIBUTION OF LOESSIAL HILLS ON THE COLUMBIA PLATEAU.

APPARENTLY ALL GRADATIONS EXIST BETWEEN A BASALT PLATEAU ALMOST PLANE, STREAM-WAYS A MILE OR <sup>in themselves</sup> SO APART, AND THE MERE BEGINNINGS OF VALLEYS (ANATONE REGION), AND A BASALT PLATEAU SO DISSECTED THAT ALMOST NO PLANE SURFACES REMAIN ON THE UPLANDS. AND NO ADEQUATE EXPLANATION FOR THE DIFFERENCES HAS BEEN FOUND. RAINFALL TODAY, ALTITUDE, DISTANCE FROM MASTER STREAM, DEPTH OF MASTER GORGE, CHARACTER OF THE FORMATION— ALL SEEM TO BE THE SAME. RECENTY OF UPLIFT IN THE UNDISSECTED TRACTS CANNOT BE ARGUED BECAUSE THE ANATONE DRAINAGE FLOWS TO THE MORE DISSECTED AREAS AND HAS DONE SO SINCE THE EROSIONAL HISTORY BEGAN.

APPARENTLY ALL GRADATIONS EXIST BETWEEN A PLATEAU WITH VERY THIN SOIL, A PLATEAU WITH ~~1/2~~ A THICK MANTLE OF FINE-TEXTURED SOIL, AND A PLATEAU WITH ITS FINE SOIL HEAPED UP IN A TUMULTUOUSLY BILLOWY TOPOGRAPHY THAT HAS FEW PARALLELS, EITHER IN THE FIELD OR ON THE MAP.

APPARENTLY THE VERY HILLY LOESS-COVERED AREAS HAVE TWO TYPES OF DRAINAGE PATTERN; ONE, THE CLOSELY SET PARALLEL DRAINAGE LINES OF THE WALLA WALLA AND WALLULA SHEETS, THE OTHER THE INTRICATE FILAGREE WORK OF THE DENDRITIC PATTERN OF THE PULLMAN AND OAKESDALE SHEETS.

APPARENTLY, WITH ALL THESE GRADATIONS, THE PRODUCTION OF ANY ONE SPECIFIED FEATURE OF THE TOPOGRAPHY CALLS ~~F~~, NOT FOR DIFFERENT FACTORS, BUT FOR DIFFERENT WEIGHTING IN THE SAME GROUP OF FACTORS.

NOT ALL OF THESE COMBINATIONS HAVE A SATISFACTORY EXPLANATION AS YET. PERHAPS THE MOST PUZZLING IS THE EXISTENCE OF LARGE PLANE TRACTS CLOSE TO AND HIGH ABOVE SUCH DRAINAGE LINES AS THE SNAKE CANYON.

BUT FOR THE PALOUSE HILL TYPE OF LOESSIAL DEPOSIT, THE NORTHERN HALF OF THE WALLA WALLA SHEET SEEMS TO OFFER DATA FOR A SATISFACTORY EXPLANATION. KELLOGG CREEK, FIELDS GULCH, SMITH SPRINGS HOLLOW, WHETSTONE HOLLOW AND OTHER VALLEYS OF SIMILAR AND SOMEWHAT SMALLER DIMENSIONS ARE ~~SO~~ ERODED IN BASALT, AT LEAST FOR THE LOWER PART OF THEIR WALLS. BUT THE MINOR DRAINAGE WAYS ARE ALL IN LOESS. EVEN THAT CURIOUS FEATURE OF EUREKA FLAT SEEMS TO BE ENCLOSED BY LOESSIAL HILLS ENTIRELY.

THE ORIENTATION OF THESE CLOSELY SPACED, SUBPARALLEL MINOR VALLEYS AND THEIR NARROW STEEP-WALLED DIVIDES IS NOT FAR FROM NNE-SSW. SOME ARE ABOUT N-S. THE DRAINAGE WAYS MAY LEAD IN THE SURFACE OF THE PLATEAU. EASY IS UNDoubtedly A MARY, MARYCLIFFE A MARY, MARYCLIFFE IN MARY. WESTERN ONE DISSECTED FROM 4000 TO 2000 FT NEARLY WEST OF POMEROY (SUNNIES)

EITHER DIRECTION THO MOST OF THEM LEAD SSW. ~~OF SOME ARE~~ THE LONGER ONES CERTAINLY DO AND ROADS FOLLOWING THESE WATERWAYS ARE STEEPER ON NORTH DOWN GRADES THAN ON SOUTH DOWN GRADES. THEY ARE RARE. HERE AND THERE ARE LEDGES OF BASALT EVEN IN THESE MINOR VALLEYS BUT THEY ARE RARE, EVEN BASALT FRAGMENTS ARE RARE.

THE DIVIDES ARE MADE UP OF A SERIES OF HILLS, RATHER THAN CONTINUOUS RIDGES. AND THE HILLS ARE STRIKING IN POSSESSING LONGER, GENTLER SOUTHERN SLOPES THAN NORTHERN. ~~THUS, BOTH THE MINOR~~ VALLEYS AND THE MINOR HILLS ARE STEEPER ON THE N, NE OR NNE.

TO THIS ITEM SHOULD BE ADDED ANOTHER VERY PREVALENT FEATURE OF THE N, NE, NNE HILLS SLOPES; IT IS THEIR AMPHITHEATER-LIKE SHAPE. MANY HILLS SEEM ALMOST LIKE BARCHAN DUNES, WITH TWO LONG SPURS AND AN ENCLOSED HOLLOW WHICH MAY HAVE SLOPES OF  $30^{\circ}$  OR MORE AND GENERALLY IS BROAD AND SHALLOW AT THE TOP AND NARROW AND DEEP AT THE BOTTOM. IN VAIN WERE SUCH FEATURES SOUGHT ON THE BROAD SOUTHERN SLOPES. THEY ARE NOT PRESENT.

NOW THIS FEATURE ALONE SUGGESTS WIND WORK. WHEN TAKEN INTO CONSIDERATION WITH THE SILTY LOESSIAL CHARACTER OF THE MATERIAL, THE FACT THAT THE HILLS ARE ALMOST WHOLLY OF LOESS TO THEIR BASES, ~~THE~~ AND THE STRIKING ELONGATION IN PARALELISM, THE CASE BECOMES VERY STRONG.

SUCH VALLEYS AS BADGER HOLLOW, FIELDS GULCH, WINNETT CANYON, TOUCHET RIVER VALLEY, ETC., WHICH ARE THE MASTER DRAINAGE LINES AND ARE WELL DOWN IN BASALT, WERE HERE BEFORE THE DEVELOPMENT OF THE LOESSIAL HILLS. THEIR COURSES WERE DETERMINED largely BY THE warped SURFACES OF THE BASALT, AND LOESSIAL DEPOSITS HAVE NOT BEEN ALLOWED TO ACCUMULATE IN THEM. BUT EARLY IN THE DEVELOPMENT OF THE DRAINAGE PATTERN, LOESS AND FINE SAND DRIVEN BY PREVAILING WINDS (DURING THE DRIER PART OF THE YEAR AT ANY RATE) BEGAN TO LODGE IN THE AREA. ACCUMULATION WAS NOT SO RAPID THAT DRAINAGE WAS INTERFERED WITH VERY SERIOUSLY. NO CLOSED DEPRESSIONS, SUCH AS THOSE AMONG SAND DUNES, DUST WHICH LODGED IN THE VALLEYS WAS SWEEPED OUT BY THE STREAMS BUT DUST WHICH LODGED ON THE INTERFLUVES REMAINED. SINCE THE MINOR STREAM WAYS WERE NOT ETCHED INTO THE BASALT, THEIR ORIENTATION WAS DEVELOPED DURING THE ACCUMULATION UNDER THE CONTROL OF THE GROWING HILLOCKS AND THE SLOPE OF THE BASALT PLATEAU IN GENERAL.

THE LINEAR DIVIDES THEREFORE ARE THE DETERMINING FEATURES OF THE PATTERN AND THEY ARE, OR HAVE BEEN, GROWING ACTUALLY HIGHER. PERHAPS THE SEPARATING LINEAR VALLEYS HAVE BEEN DEEPENED (WHERE BASALT LEDGES SHOW, THIS INFERENCE IS FAIR ENOUGH), PERHAPS THEY HAVE BEEN AGGRADED SOMEWHAT AS THE HILLS HAVE GROWN.

ONE DIFFICULTY WITH THIS INTERPRETATION IS THAT LINEAR DUNES (AND THESE ARE ESSENTIALLY SUCH) ARE NOT COMPOSED OF SEPARATE DUNE HILLOCKS BUT HAVE FAIRLY UNIFORM SIDES AND CRESTS.

SAMPLES OF THE LOESS OF THIS TRACT SHOULD BE SECURED AND COMPARED WITH SAMPLES FROM THE LOESSIAL TRACTS WHERE DENDRITIC PATTERN PREVAILS. THE LOESS SHOULD BE COARSER IN THE LINEAR ONES, IF THE HYPOTHESIS ADVANCED IS CORRECT.

TRACTS WHICH BEAR THE PALOUSE HILLS OF LOESS GRADE WITHIN A FEW MILES TO TRACTS WHERE THE BASALT IS JUST UNDER THE GRASS ROOTS (OR NEARLY SO) AND THE PATTERN IS MUCH COARSER TEXTURED, WITH RUNNING WATER OBVIOUSLY THE ONLY AGENT WHICH HAS MODIFIED THE DIASTROPHICALLY DETERMINED MAJOR FEATURES. DAYTON LIES IN SUCH A TRANSITION BELT. TO THE WEST ARE PALOUSE HILLS; INDEED, SOME DIVIDE SUMMITS AT DAYTON ARE CRENULED LIKE A SNOWDRIFT WHOSE SNOW HAS BEEN CARRIED OVER TO MAKE A CORNICE. OF COURSE, THERE IS NO OVERHANG HERE. BUT EAST OF DAYTON, THE TOPOGRAPHY HAS NO LOESSIAL ACCUMULATIONS ON THE DIVIDES. NOR NORTH TO THE SNAKE FROM DAYTON.

BUT NORTH OF THE SNAKE, THE WHOLE PLATEAU EAST INTO IDAHO IS DIVERSIFIED WITH THE LOESSIAL HILLS. THEY COME ALMOST TO THE BRINK OF THE LEWISTON MONOCLINE, ABOUT 2750, THO SOUTH OF LEWISTON THERE ARE NONE ON THE 1400 FT LEWISTON ORCHARDS PLATEAU NOR ON THE HIGHER PORTIONS ABOUT ANATONE OR GRANGEVILLE.

EUREKA FLAT SEEMS ENCLOSED BY LOESSIAL HILLS. LEIGHTON SUGGESTED (GRAVEL SUPPLIES BULLETIN OF WASH. GEOL. SURVEY) THAT IT MIGHT BE AN OLD COURSE OF THE SNAKE. ITS FORM AND LOCATION DO NOT SUGGEST IT BUT IF IT IS, THE LOESSIAL HILLS ARE OLDER, ELSE THEY WOULD HAVE DEVELOPED IN IT AS WELL AS MARGIN IT AFTER IT WAS ABANDONED. AND IF THEY ARE OLDER, THE SNAKE AT PERRY HAS CUT FROM 1400 PLUS OR MINUS DOWN TO 500 SINCE THE CHANGE IN DRAINAGE. THIS SEEMS UNLIKELY.

THE FLAT OPENS NORTHWARD TOWARD THE SNAKE AT ABOUT THE LEVEL OF THE RIDGES BETWEEN THE LOCAL DRAINAGE LINES. FILL THEM UP AND THE FLAT COULD BE CARRIED RIGHT THRU TO THE SNAKE.

OR IS EUREKA FLAT TO BE CORRELATED WITH THE OLDER VALLEY FLOOR REMNANTS ABOVE LEWISTON? NOTHING OF THESE FEATURES HAS BEEN IDENTIFIED THUS FAR BELOW LEWISTON.

WALLULA GATEWAY JULY 12 1926

WEST SIDE EXAMINED ABOVE THE CLIFF SUMMITS. NEW EVIDENCE SUPPORTING THE INTERPRETATION OF THE SCABLAND FLOOD, AND NEW CONVICTIONS FROM SURVEY OF THE FIELD PREVIOUSLY SEEN. CHANNELS AMONG THE KNOBS HAVE ~~1/2~~ BASINS IN THEM AND LARGE ROUNDED MOUNDS OR LOW HILLS ON THE LEETE OF LEDGE OUTCROPS. THIS, WITH THE SCABBY LEDGES IN THE CHANNEL SIDES AND IN THE SLOPES OF THE BUTTES IS NOTHING ELSE THAN SCABLAND.

AND THE FLOOD WAS DEEPER AT THE HEAD THAN PREVIOUSLY THOUGHT. A FLAT-TOPT HILL, NEARLY A MILE IN MAX. LENGTH, AND NEARLY A MILE AND A HALF FROM THE RIVER, RISES ABOVE 1150. IT IS SEPARATED FROM THE HIGHER LAND FARTHER WEST BY A CHANNEL WHICH AT THE HEAD, THE NORTHERN END, IS MORE THAN 1100 FT. A.T. THIS CHANNEL DESCENDS SOUTHWARD 150 FEET IN 3/4 MILE OVER SCABBY LEDGES AND WITH SCABBY SIDES FARTHER SOUTH. AT THE CHANNEL HEAD, THE WATER COURSE ISN'T VERY WELL DEFINED. ITS FLOOR HAS LARGE LOW MOUNDS AND BROAD LOW DEPRESSIONS AS THO A GROUP OF RIVER BARS LAY HERE. SOUTHWARD, WHERE DEEPER, A CLEARLY MARKED BAR FILLS THE ENTIRE CHANNEL. IT RISES 25 FT FROM A BASIN ON THE UPSTREAM SIDE (BASIN NOW DRAINED BY A SMALL GULLY THRU THE BAR) AND IT DESCENDS 45 FT TO THE GENERAL CHANNEL FLOOR ON THE SOUTH OR DOWNSTREAM SIDE. CHANNEL WALLS ARE ALSO WELL MARKED HERE AND THE WHOLE AFFAIR CLEARLY IS AN EROSIONAL FEATURE OF THE FLOOD, MODIFIED AND ENLARGED FROM AN EARLIER DRAINAGE LINE THAT TOOK CARE ONLY OF IMMEDIATE RUNOFF.

A TRIB OF THIS PRE-SPOKANE DRAINAGE HERE WAS PARTIALLY BLOCKED BY THE GROWTH OF THE TRANS-CHANNEL BAR. ITS RELATIONS ARE FAIRLY CLEAR <sup>subtributary</sup>. IT HAS CLEARED OUT A GULLY THRU THE LOWER EDGE OF THE BAR, 10 FT. OF MORE IN DEPTH, JUST AS THE BASIN ABOVE THE BAR HAS GIVEN RISE TO A GULLY. THE TRIB IS A VERY NARROW GULLY OR RAVINE ITSELF, CUT IN THE BASALT WEST OF THIS WALLULA GATEWAY SCABLANDS. IT TAKES CARE OF PERHAPS A TENTH OF THE RUNOFF WHICH COMES FROM THE HIGHER WESTERN SLOPE. IT ENTERS WELL TOWARD THE UPPER END OF THE CHANNEL. THERE SHOULD THEREFORE BE SOME NATURAL PROPORTIONAL RELATIONS BETWEEN CHANNEL AND TRIBUTARY, IF THE CHANNEL IS LARGE THE PRODUCT OF PRE-SPOKANE RUNOFF.

BUT THE CHANNEL IS GREATLY OUT OF PROPORTION TO ITS TRIB. IT IS TOO DEEP (TRIB. HAS APPARENTLY BEEN REJUVENATED AT THE LOWER END) AND IT IS MUCH TOO WIDE. THIS IS ONLY ANOTHER LINE OF EVIDENCE POINTING TO THE OCCURRENCE OF AN UNPARALELED EPISODE - THE SPOKANE FLOOD.

See 1926 map for complete verification

ANOTHER SIGNIFICANT FEATURE OF THE CHANNELS AND SCABLAND FORMS ON TOP OF THE WESTERN CLIFFS OF WALLULA GATEWAY IS THE NOTEWORTHY DESCENT TO THE SOUTH, PARALLEL TO THE COLUMBIA. THE PARTICULAR CHANNEL ABOVE DISCUSSED SHOWS THIS VERY WELL AND IF IT IS LARGELY AN EROSIONAL FEATURE OF THE FLOOD, IT CLEARLY RECORDS A VERY PRONOUNCED DESCENT SOUTHWARD HERE OF THE MAIN GATEWAY FLOOD, ELSE THERE COULD BE NO GRADIENT FOR THE SHORT CHANNEL.

THEY HILL (1150 + OR -) SEPARATED BY THE CHANNEL FROM THE MOUNTAIN HIGHER LAND FARTHER WEST, APPARENTLY WAS NOT REACHED BY THE FLOOD. IF THE TOPOGRAPHIC MAP MAY BE TRUSTED HERE, THE UPPER LIMIT OF THE FLOOD WATERS WAS ABOVE 1100 AND BELOW 1150. DOUBT AS TO ACCURACY IS INTRODUCED BECAUSE THE FARM HOUSE MARKED 980 IS ONLY 120 FEET BY ANEROID BELOW THE CHANNEL FLOOR AT THE HEAD. ERROR PROBABLY ISN'T GREAT, HOWEVER.

Map shows only 1100 (+20)

WALLULA GATEWAY JULY 13 1926

EAST SIDE EXAMINED RATHER COMPLETELY. IT IS SPLENDID SCABLAND FROM RIVER LEVEL UP TO 1100 AND HAS SCABBY LEDGES IN MANY PLACES UP TO 1150 AND 1175. THE UPPER LIMIT IS MARKED BY A REAL SCARP LIKE THE SCARPS OF THE LOESSIAL HILLS ALONGSIDE SCABLAND, AT 1150 JUST EAST OF THE INDICATED SECONDARY ROAD UP THE HILL. THIS SCARP SHOWS THAT THERE IS A DEPTH HERE OF 20-30 FT. OF LOESS. BETWEEN THIS SECONDARY ROAD AND THE ROAD SOUTH OUT OF WALLULA IS A BROAD SHELF OR SHOULDER AT 1150, WITH THE 1200 FT CONTOUR RINGING A SMALL PORTION OUT TOWARD THE TIP. THIS WHOLE SHOULDER HAS BEEN STRIPPED OF ITS SOIL AND NOW BEARS ONLY BROKEN BASALT RUBBLE AND THIN WIND DRIFT SOIL. IT OBVIOUSLY HAD WATER ACROSS IT AND THUS 1200 IS THE HIGHEST PLACE RECORDED IN WALLULA GATEWAY WHERE THE SPOKANE FLOOD REACHED. 1150+ (AND PERHAPS 1200) NEARLY 1200) ON

THE WEST SIDE OF THE RIVER AT THE NORTH END SEEKS TO HAVE BEEN SPARED. AND 1100+ SEEMS TO HAVE ESCAPED THE FLOOD ON THE EAST SIDE ON THE PROMINENT HILL 100 FT. HIGH ABOUT A MILE SW OF THE 1200 SHOULDER. PERHAPS THE LOWER PLACES NOTED WERE SPARED BECAUSE OF SUFFICIENT GRADIENT IN THE RIVER SURFACE ITSELF IN THE DISTANCE INVOLVED. IT IS CLEAR FROM A SURVEY OF THE EAST SIDE BELOW 1150 THAT A TREMENDOUS TORRENT RIPPED UP THE PRE-SPOKANE VALLEY SLOPES HERE. PERHAPS THE SITUATION HERE WAS SOMEWHAT SIMILAR TO THAT AT KETTLE FALLS TODAY, WHERE THE COLUMBIA RIVER SURFACE DESCENDS AMONG ITS ROCKY ISLANDS AND OVER SUBMERGED LEDGES WITH TORRENTIAL VELOCITY AND WITH NOTABLE DIFFERENCES OF LEVEL OF THE WATER IN ANY ONE CROSS SECTION. ONE SIDE OF THE STREAM IN SUCH A SITUATION MAY BE SEVERAL FEET HIGHER THAN THE OTHER, THE MIDDLE MAY BE HIGHER THAN THE SIDES, AND THE SLOPE OF THE WATER SURFACE MAY BE STEEPER ON ONE PART THAN IN ANOTHER. WHAT IS REQUIRED FOR SUCH RELATIONS IS GREAT VELOCITY AND NOTABLE IRREGULARITIES IN THE RIVER BED AND SIDES.

VICINITY OF UMATILLA JULY 14 1926

UMATILLA GRAVEL PIT, EAST OF THE HIWAY, RR AND TOWN, IN TERRACE 380. THE PIT BUT 400 ON THE MAP A LITTLE BACK FROM THE EDGE OF THE TERRACE SCARP  $\frac{1}{4}$  TO  $\frac{3}{4}$  OF THE GRAVEL IS BASALT, BUT AVERAGE IS BELOW THE MEAN. PERHAPS 40% IS AN ADEQUATE FIGURE. THERE IS A HIGHER % AMONG OF BASALT AMONG THE SMALLER FRAGMENTS AND AMONG THE LARGER THAN AMONG THE MEDIUM SIZED. BASALT FRAGMENTS COMMONLY NOT AS WELL WORN AS NON-COLUMBIA.

BEDDING IS NOT DELTA TYPE, BUT FORESETS OF SHALLOW DEPTH ARE COMMON.

ALTITUDE OF 400 SUGGESTS CORRELATION OF THIS GRAVEL WITH VISTA 500 FT TERRACE WEST OF KENNEWICK BUT APPARENTLY IT RESTS ON ERODED FLANKS OF UMATILLA BUTTE AND SHOULD BE CONSIDERED SCABLAND GRAVEL, WITH DEBRIS FROM THE DESTRUCTION OF PORTIONS OF THE VISTA TERRACE.

UMATILLA BUTTE IS A SPLENDID PIECE OF SCABLAND. THE HEART OF THE UPFOLD APPARENTLY HAS BEEN TORN OUT AND THE GENTLER WESTERN LIMB IS GASHED AND CORRUGATED, WITH ROCK BASINS, HILLS AND HOLLOWKS OF BARE CRUMBLING BASALT. THE SCABLAND HERE CLEARLY EXTENDS NORTHWARD AND NORTH-EASTWARD UNDER THE GRAVEL OF THE BIG BAR WHICH TERMINATES AT UMATILLA.

THAT THIS GREAT GRAVEL DEPOSIT IS A BAR, AND NOT A SIMPLE TERRACE REMNANT IS OBVIOUS FROM A SURVEY OF ITS SURFACE, EITHER IN THE FIELD OR ON THE MAP. IT IS HIGHEST NEAR THE RIVER AND SLOPES GENTLY SOUTHWARD AWAY FROM THE RIVER TO LIE LOWEST NEXT TO THE BUTTE. LOGICALLY, THE BUTTE SHOULD NOT BE BURIED IN GRAVEL. IT SHOULD HAVE, AS IT DOES HAVE, A LOWER TRACT ALONG THE EAST SIDE, LIKE THE FOSSE EAST OF ROCKY BUTTE IN PORTLAND. BUT THIS ISN'T A FOSSE, IT IS ONLY A GENTLE DOWN SLOPE OF THE BACK SIDE OF THE BAR. THERE IS MUCH SCABLAND NEARER THE RIVER IN THIS 500 FT BAR, INDEED, SCABLAND SURFACES OF BASALT PROJECT HERE AND THERE AT THE SURFACE OF GRAVEL PLAIN BETWEEN UMATILLA AND COLD SPRINGS.

#### JUNIPER CANYON

THE SPOKANE FLOOD OVERRAN THE UPSTREAM SPUR BETWEEN THIS CANYON AND THE COLUMBIA AND MADE GOOD SCABLAND OF ITS SUMMIT. TWO OF THE ISOLATED BUTTES ON ITS SUMMIT ARE EACH ABOUT 50 FT HIGH AND THE WHOLE ROUGHENED, ROCKY TOP IS IN STRIKING CONTRAST WITH THE SLOPES OF THE SAME SPUR A MILE FARTHER EAST WHERE THE NORMAL PROFILES AND WASTE-COVER OBTAINS. UPPER LIMIT OF SPOKANE FLOOD ON THIS SPUR IS A BIT DIFFICULT TO DETERMINE. IT CERTAINLY IS ABOVE 1050 AND ONE BUTTE WHICH HAS THE 1100 CONTOUR APPEARS SCABBY ON TOP. BUT THIS WAS SEEN 1 1/2 MILES AWAY AND IT MAY WELL BE THAT THE BUTTE RESULTED FROM LATERAL EROSION OF THE FLOOD AND NEVER HAD ITS TOP SUBMERGED. 1075 IS A FAIR FIGURE, FOR THAT WILL GIVE 25 FEET OF WATER OVER MOST OF THE SPUR.

OTHER EVIDENCE VISIBLE HERE AS TO THE UPPER LIMIT CONSISTS OF DEFINITE CLIFFS OR SCARPS IN THE WIND-BLOWN SAND AND DUST WHICH DEEPLY MANTLES THE BASALT BACK FROM THE CLIFFS OF THE COLUMBIA. ONE SUCH SCARP IS ON THE SOUTH SIDE OF JUNIPER CANYON AND IS 100 FEET HIGH WITH THE 1000 FT CONTOUR AT THE BASE, AND A FLATTISH TRACT IN FRONT OF IT, THO NOT SCABBY. ANOTHER SUCH SCARP CAN BE SEEN ON THE WASHINGTON SIDE AT THE SAME ALTITUDE, REACHING BOTH EAST AND WEST FROM SPAW CANYON. THE FLATTISH TRACT IN FRONT IS SCABBY HERE BETWEEN SPAW AND THE CANYON 1 1/2 MILES FARTHER EAST. JUST HOW HIGH THE WATER STOOD ON THESE CLIFFS IS IMPOSSIBLE TO SAY, BUT IT WAS CERTAINLY HIGH ENOUGH ABOVE 1000 TO GIVE EFFECTIVE DEPTH FOR THE LATERAL EROSION THAT MADE THE SCARPS.

THE SPUR EAST OF THE CANYON JUST REFERRED TO (1 1/2 MI. E OF SPAW) CARRIES THE 1000 FOOT CONTOUR ON THE VERY BRINK. THE TOP OF THE SPUR LOOKS PERFECTLY FLAT AND THO IT CANNOT BE SAID TO HAVE SCABLAND ON IT, APPARENTLY IT HAS LOST THE WIND-DRIFT COVER AND THEREFORE SHOULD BE MAPPED AS BELOW THE UPPER LIMIT OF THE MAXIMUM FLOODING.

JUNIPER CANYON HAS A GRAVEL-COVERED NORTHERN WALL, IN WHICH EROSIONAL FURROWS DISCOVER NO BASALT LEDGES. THIS IS JUST WHERE ALL GRAVEL DEPOSITS OCCUR IN MOUTHS OF TRIBS WHOSE UPSTREAM SPUR WAS OVERRUN BY THE MIGHTY TORRENT.

PALOUSE HILLS BEGIN ALMOST ON THE EASTERN MARGIN OF THE UMATILLA SHEET AND COVER THE PLATEAU TOP SOUTHWARD AND EASTWARD. BUT NEARER THE COLUMBIA THE SOIL IS SAND AND THE HILL FORMS ARE ABSENT THO SAND DUNES ARE RECOGNIZABLE. APPARENTLY HERE IS A GRADATION FROM SOURCE (THE COLUMBIA VALLEY) TO SAND FOR FIVE OR TEN MILES AND THEN TO LOESS FARTHER BACK. TO MAKE THE GRADATION COMPLETE, IT SHOULD BE POSSIBLE TO GO FURTHER BACK THAN THE PALOUSE LOESSIAL HILLS AND FIND THE PLATEAU MODIFIED ONLY BY STREAM DISSECTION AND THE LOESS THIN OR ABSENT. IF THIS IDEA BE CORRECT, EACH TRACT OF LOESSIAL HILLS SHOULD LIE WITH DEFINITE RELATION TO A SOURCE OF DUST. THE DUST IS TO BE CONSIDERED AS REALLY A FINE SAND. IT DOES DRIFT LOW, SO FAR AS GUSTS ACROSS SUMMER FALLOW INDICATE.

AMPHITHEATER HEADED BY GULLIES ON THE NORTHEAST SLOPES AND LONG, GENTLE SOUTHWEST SLOPES THAT ARE CHARACTERISTIC OF THESE LOESSIAL HILLS.

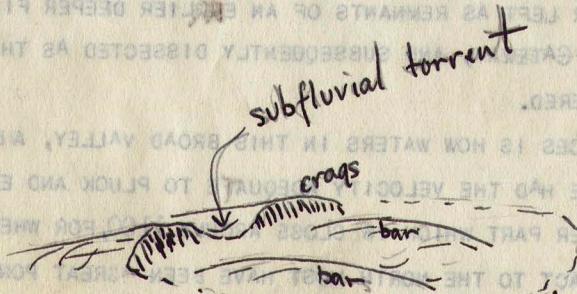
#### GABLE MTN. VICINITY JULY 15 1926

GRAVEL IN 500 FT TERRACE ABOUT 2 1/2 MILES SOUTH OF HANFORD IS ABOUT 1/3 NON-BASALT. FORESET CURRENT BEDS DIP SOUTHWARD. AMONG THE COBBLES THERE IS NO GREATER % OF BASALT THAN THE AVERAGE. NOR DOES IT APPEAR AMONG THE 1/2 INCH PEBBLES. AMOUNT OF WEAR APPARENTLY THE SAME FOR BASALT AND NON-BASALT. WALK A LITTLE WAY NORTH OF THE ROADSIDE PIT, HOWEVER, ARE MANY LARGE COBBLES AND SMALL BLDRS, NOT WELL ROUNDED, ALL OR ALMOST ALL OF BASALT.

GABLE MTN AND GABLE BUTTE AND THEIR CLOSELY ASSOCIATED GRAVEL DEPOSITS AFFORD AS REMARKABLE AND CHARACTERISTIC A SCABLAND ASSEMBLY AS ANY IN THE PLATEAU, SAVE ONLY ~~THE ABSENCE OF LOESSIAL SCARPS AND ABANDONED WATERFALLS.~~ THERE ISN'T THE SLIGHTEST DOUBT THAT THE SPOKANE FLOOD OVER-RAN THE HIGHEST SUMMIT (1116). THERE ISN'T THE SLIGHTEST DOUBT THAT EVERY FEATURE OF THE GRAVEL PLAIN (SAVE THE SAND DRIFTS) IS THE PRODUCT OF THE SAME FLOOD. THE TOPOGRAPHIC MAP, WHICH HAS BEEN DEPENDED ON PREVIOUSLY FOR THE SCABLAND INTERPRETATION, FALLS FAR SHORT OF EXPRESSING THE SITUATION FULLY.

GABLE BUTTE CONSISTS OF TWO GUTTED ANTICLINAL STRUCTURES, THE NORTHWESTERN ONE STRIKING PARALLEL TO AND SLIGHTLY NORTH OF THE SOUTHWESTERN ONE. IN BOTH FOLDS, THE CORE OF THE STRUCTURE IS GONE—GONE IN TERMS OF THE SCABLAND FLOOD'S EROSION. IN THE HEART OF THE SOUTHWESTERN ONE IS A TRUE ROCK BASIN 40 TO 50 FEET DEEP. THIS BASIN CONTAINS TWO FINE BARS LYING PARALLEL AND TO THE LEE (NE BY E) OF TWO RAGGED SPURS OF THE DIPPING FLOWS. A NOTCH BETWEEN THE FLOWS ALLOWED A BIG GUSH OF WATER IN THE LOWER PART OF THE TERRAIN TO ENTER AND PREVENT THE TWO BARS FROM COALES-CING AND BECOMING ONE.

AT THE TIME OF THE GREATEST FLOODING AT THE GATEWAY WAS MIDEMBED AND DEEPENED AND THE FLOOD WAS LOWERED. A CONSTANT BURSE IN THE GABLE GATEWAY IS HOW WATER IN THIS BROAD VALLEY, AFT. OF WHICH THE FLOOD TO PASS THRU THE NARROW GATEWAY, COULD HAVE HAD THE FLOOR OF THE FLOOD DEEPER, TILL IT WAS DEEPER THAN THE FLOOD TO PASS SO AWESINSLY. ESPECIALLY THE DEEPER PART OF THE FLOOD IN THE GATEWAY REACHED HIGH, THIS SHOWS THAT THE COLUMBIA IN OUT 11 MONTHS ONLY A FEW HOURS ON GABLE DOKE MADE THESE THINGS. THERE REALEDLY NEARER COULD HAVE DONE THESE THINGS.



THE STREAM WHICH MADE THESE WAS BIG ENOUGH TO CONTROL THE SITUATION SO THAT NO FILLING OF THE ENTIRE BASIN OCCURRED; INDEED, IT FIRST MADE THE BASIN. AND THAT STREAM CEASED ITS WORK SO SUDDENLY THAT NO FILLING OVER AND AROUND THE BARS RESULTED. AND NOTHING HAS HAPPENED HERE SINCE, EXCEPT TALUS GROWTH AND WIND DRIFT.

ANOTHER PORTION OF THIS SOUTHWEST PART OF GABLE BUTTES, THE PROMINENT CLIFF ALONG THE SOUTH MARGIN, HAS A DEPRESSION IN FRONT (SOUTH) OF IT, ROCK-WALLED ON THE NORTH, GRAVEL-RIMMED ON THE SOUTH, WEST AND EAST. THIS DEPRESSION IS 50 FEET BELOW THE GRAVEL TO E AND W. IT IS A CURRENT-FORMED AFFAIR, THE GRAVEL DEPOSIT GROWING AROUND IT BUT VIGOR OF CURRENT PREVENTING SUCH IN THE BASIN. THIS WAS CAUSED EITHER BY A LATERAL CURRENT OR, MORE PROBABLY, BY A DEFLECTION EDDY LIKE THAT EAST OF ROCKY BUTTE IN PTLD. IT CAN ONLY HAVE BEEN FORMED BY A GREAT CURRENT IN A DEEP RIVER.. AND IT WAS ABANDONED VERY QUICKLY AND ONLY WIND-BLOWN SAND HAS MODIFIED IT SINCE.

GABLE MTN'S WESTERN FRONT SHOWS IT TO BE AN ASYMMETRICAL ANTICLINE, PROBABLY THE SAME STRUCTURE AS THE SW ONE OF GABLE BUTTE. ITS NORTHERN DIP IS  $14^{\circ}$ , ITS SOUTHERN IS ALMOST VERTICAL, SO THAT THE POLYGONAL ENDS OF LARGE COLUMNS MAKE A CURIOUS PATTERN IN THE BARE LEDGES. MOST OF THE SOUTHERN LIMB HAS BEEN ERODED AWAY, LEAVING STEEP BARE WALLS AND CLIFFS AND CRAGS.

THE SCABLAND FEATURES OF THE WEST END OF GABLE MT ARE VERY STRIKING INDEED. EVERY FEATURE OF BASALT ERODED BY A POWERFUL TORRENT IS EXHIBITED. THE PLANE SURFACE ON THE NORTH SIDE, THE DIP SLOPE, IS VERY MUCH ROUGHENED BUT <sup>the</sup> RELIEF <sup>of this roughness</sup> IS PROBABLY NOT MORE THAN 20-25 FT. THE CREST CARRIES JAGGED PINNACLES AND TABULAR BUTTES, THE SOUTHERN SLOPE IS LARGELY A GREAT CLIFF EXCEPT FOR TALUS.

AND THE WEST END OF GABLE MTN. HAS A GREAT FOSSE OR EDDY BASIN COMPLETELY AROUND THE PROW. THIS IS 85 FT BELOW THE HIGH BAR TO THE NORTHWEST AND 150 FEET BELOW THE HIGH BAR TO THE SW. ITS BOTTOM IS AT THE LEVEL OF COLUMBIA RIVER TO THE NORTH. IT HAS THREE DEPRESSION CONTOURS. IT COULD NEVER BE FORMED EXCEPT IN A HUGE STREAM.

IN THIS DEFLECTION EDDY BASIN STAND TWO OR THREE GOOD GRAVEL BARS, FAR SMALLER THAN THE GREAT AFFAIRS ON EITHER SIDE, BUT ABOUT 25-30 FT HIGH THEMSELVES. SOME MINOR SWIRLS IN THE CLOSING STAGES OF THE SPOKANE FLOOD CAUSED THEIR GROWTH BUT THE PLACE WAS ABANDONED SO QUICKLY THAT THEY STAND AND THE BASIN STANDS ALMOST AS THE ENSEMBLE WAS ~~originally~~ FORMED.

THE EASTERN END OF GABLE MTS HAS A LONG LEVEL-TOPPED TERRACE DEPENDING SOUTHEAST BY EAST AT 500 FT A.T., A FAVORITE ALTITUDE FOR GRAVEL TERRACES IN THIS PART OF THE COLUMBIA VALLEY. ABOVE IT IS ANOTHER BAR, ITSELF 675 TO 700 FT AT AND DEPENDING IN THE SAME FASHION. IT IS MOSTLY BASALTIC RUBBLE, SO FAR AS THE WIND-DRIFTED SAND ON IT PERMITS EXPOSURE, BUT THERE ARE VERY MANY FAR-TRAVELED, ROUNDED PEBBLES WHICH INDICATE THAT THEY WERE CARRIED THAT HIGH, EITHER BY ASCENDING LATENT CURRENTS FROM THE LOWER BARS OR LEFT AS REMNANTS OF AN EARLIER DEEPER FILL BY THE FLOOD AT THE TIME OF THE GREATEST PONDING AT THE GATEWAY, AND SUBSEQUENTLY DISSECTED AS THE GATEWAY WAS WIDENED AND DEEPENED AND THE FLOOD WAS LOWERED.

A CONSTANT PUZZLE IN THE GABLE EMINENCES IS HOW WATERS IN THIS BROAD VALLEY, ALL OF WHICH HAD TO PASS THRU THE NARROW GATEWAY, COULD HAVE HAD THE VELOCITY ADEQUATE TO PLUCK AND ERODE THESE HILLS SO AMAZINGLY. ESPECIALLY THE UPPER PART WHICH IS CLOSE AROUND 1100, FOR WHEN THE FLOOD IN THE GATEWAY REACHED 1150, THIS WHOLE TRACT TO THE NORTH MUST HAVE BEEN A GREAT POND.

BUT IT NEEDS ONLY A FEW HOURS ON GABLE BUTTE AND MTN. TO CONVINCE ONE THAT THE COLUMBIA IN NORMAL PHASE NEVER, NEVER COULD HAVE DONE THESE THINGS. THERE REALLY ARE NO TERRACES HERE, THEY

ARE ALL BARS. AND BARE ROCK CLIFFS AT THE SUMMIT (1100+) WOULD LONG SINCE HAVE BEEN GRADED DOWN TO GENTLE SOIL-COVERED SLOPES WHILE THE RIVER EXCAVATED TO 400. INDEED, THEY NEVER WOULD HAVE BEEN SO STEEP BY THIS ~~FOR~~ ORIGIN.

ISN'T IT POSSIBLE THAT THE FAVORITE 500 FT LEVEL OF MANY OF THESE BARS IS A RELIC OF A PRE-SPOKANE RIVER TERRACE, PERHAPS OUTWASH, PERHAPS CAUSED BY SUBSIDENCE, LIKE THE CENTRAL FERRY TERRACES ON THE SNAKE, AND THAT THE SPOKANE FLOOD SIMPLY MODIFIED THIS EXISTING FILL, EXCAVATED HERE AND THERE, DEPOSITED ON TOP HERE AND THERE AND WORKED THE COARSE BOULDERY RUBBLE DERIVED FROM THE CLIFFS INTO THE MODIFIED FORMS?

BOWLER BARS OR BOULDER-COVERED BARS LIE TO THE IMMEDIATE LEW OF MANY OF THESE CLIFFS. BLDRS ALL OF ANGULAR BASALT. ORIENTATION OF THE BARS AND LOCATION OF THE GREATEST CLIFF-MAKING SUGGESTS THAT THE MAIN CURRENT WHICH OVERRAN THESE BASALT HILLS CAME FROM THE SW BY W. THIS WAS IN CONFORMITY WITH THE PRE-SPOKANE VALLEY SHAPE, IN OBEDIENCE TO WHICH THE GREAT STREAM, LIKE THE PRESENT ONE, WAS THROWN AROUND A CURVE BY IMPINGEMENT AGAINST THE CLIFFS OF THE PRIEST RAPIDS RANGE.

#### SCABLADS AND OTHER FEATURES IN THE WALLA WALLA VALLEY

JULY 17 1926

AN EMINENCE OF BASALT SEVERAL SQUARE MILES IN AREA PROJECTS OUT FROM THE WALLULA UPFOLD INTO THE STRUCTURAL VALLEY TO THE NORTH AND DETERMINES THE LOCATION OF THE CANYONS OF WALLA WALLA RIVER AT DIVIDE, REESE AND FARTHER WEST. STRUCTURE OF THIS BASALT UNKNOWN.

THE CANYON WALLS, THE UPPER SLOPES AND EVEN THE TOPS OF THE HILLS HERE ARE ROUGH AND ROCKY EXCEPTING ALWAYS THE PREVALENT EOLIAN SAND. A POMINENT BUTTE EAST OF REESE IS AN ISOLATED SCABLAND BUTTE. ALTITUDES ARE LOW HERE, THE BUTTE IS 700 FT AT AND THE SITUATION IS IN THE PONDING ABOVE THE GATEWAY. IT IS AS INSTRUCTIVE AS GABLE BUTTES AND GABLE MTN. TO SHOW THAT THE GREAT FLOOD MOVED WITH SUFFICIENT VIGOR EVEN IN THIS PONDED TRACT TO ROUGHEN THE SURFACE OF OUTCROPPING BASALT.

WHERE DID THE WATER COME FROM? WHICH WAY WAS IT FLOWING HERE? TO ANSWER THIS, ANOTHER TRIP WAS MADE INTO EUREKA FLAT. A VERY INTERESTING SITUATION WAS FOUND. SEEN FROM THE E-W ROAD THREE MILES WEST OF EUREKA, THE HILLS TO THE NORTH HAVE THE LOESSIAL PROFILES AND ARE CLEARLY WELL MATURED. BUT JUST TO THE WEST IN THE SAME LINE OF HILLS, ALMOST STRAIGHT SOUTH OF SIMMONS, THESE HILLS ARE SCABLAND, AND ALMOST AS HIGH AS THE APPARENTLY LOESSIAL HILLS JUST EAST. THIS FLOOD WATER CAME OUT OF THE SNAKE OVER ONTO THE EUREKA FLAT'S SOUTHERN EXTENT. TWO SPLENDID NOTCHES, ONE OF THEM A REAL SCABLAND CHANNEL, EAST AND A LITTLE NORTH OF PAGE AND STRAIGHT SOUTH OF A MILE AND A HALF STRAIGHT N-S PART OF THE SNAKE. THIS WATER RAN TWO MILES SOUTH AND THEN SPREAD OUT OVER THE FLAT.

THIS FLAT IS A CURIOUS THING. APPARENTLY THERE NEVER WERE ANY LOESSIAL HILLS HERE. THE ALTERNATIVE WOULD BE THAT THEY ONCE WERE HERE, AND WERE SWEEPED OFF BY THE FLOOD. BUT THERE ARE NO LOESSIAL SCARPS AND THE TRACT COULD HAVE HAD NO PRONOUNCED CURRENT. I PREFER TO CALL ALL THIS LARGE AREA OF SAND SW OF EUREKA A PART OF THE ORIGINAL EUREKA FLAT. BUT WHY NO LOESSIAL HILLS EVER GREW IS A PUZZLE FOR WHICH THERE IS NO ADEQUATE EXPLANATION AT PRESENT.

YET THE FLOOD AT DIVIDE AND REESE ERODED! AND THERE ARE LOESSIAL TRACTS NORTH OF WALLA WALLA RIVER, BETWEEN DIVIDE AND TOUCHET. THESE EXTEND AS FAR NORTH AS PLEASANT RIDGE SCHOOL

WHY WERENT THEY SWEPT OFF IF THE WATER AFTER CROSSING THEM ERODED THE WALLA WALLA CANYON? THE ONLY EXPLANATION SEEMS TO BE THAT CONFINEMENT IN THE CANYON, CONFINEMENT ONLY OF THE BOTTOM OF THE FLOOD, MADE IT POSSIBLE TO ERODE BY WATER THAT CROSSED A BROAD PLAIN WITHOUT ALTERING IT NOTABLY.

IT MAY BE THAT THERE IS SCABLAND UNDER THIS PLAIN BUT IF SO IT IS WELL COVERED BY DUNESAND. DUNES HERE ARE ELONGATED WITH THE WIND.

THE TOUCHET CANYON FROM LAMAR TO TOUCHET SEEMS TO MARK THE WESTERN LIMIT OF THE LOESSIAL HILLS. THE LINEAR PATTERN IS WELL MARKED EAST OF THE TOUCHET BUT ABSENT IN THE FLAT OR THE TRIBS FROM THE FLAT TO THE TOUCHET.

BIG BASALT HILL IN THE ANGLE BETWEEN WYNETT CANYON AND TOUCHET VALLEY. BASALT SEEMS TO CONSTITUTE MOST OF THE HILL. OBVIOUSLY A LOT OF RELIEF IN THE BASALT BEFORE LOESS ACCUMULATION. SEE ALSO WELL LOGS ABOUT EUREKA.

BIG TERRACE OF STRATIFIED SAND AND SILT IN WALLA WALLA RIVER. ESPECIALLY MARKED AT TOUCHET. CLASTIC DIKES PROMINENT IN IT. ARE THESE STRATIFIED SILTS AND SANDS A RECORD OF THE PONDING? IT WOULD SEEM SO THO AT WALLULA SOME OF THESE STRATA EXPOSED AT THE SURFACE BY WIND EROSION ARE SUN-CRACKED! IF THIS IS DUE TO WETTING AND DRYING IN PRESENT POSITION, IT IS OF NO SIGNIFICANCE IF ORIGINAL, IT MEANS THE SILT AND SAND ARE SIMPLE ALLUVIAL ACCUMULATIONS, NOT FLOOD SEDIMENTS.

EUREKA FLAT REALLY EXTENDS OVER INTO DRY HOLLOW, THO THERE ARE LOESSIAL HILLS BETWEEN, ABOUT 100 FT HIGH. THESE ARE THE INCIPIENT FORMS WHICH ELSEWHERE HAVE COVERED THE ENTIRE PLATEAU.

WALLA WALLA VALLEY ABOUT THE CITY IS REALLY A BROAD LOW TRACT OF THE BASALT SURFACE WHICH HAS FEW AND LOW LOESSIAL HILLS IN GENERAL AND NONE OVER LARGE AREAS. NORTHWARD FROM THIS, THE HILLS BEGIN AS RATHER UNDERSIZED WITH VERY GENTLE SLOPES, AND STILL FARTHER NORTH THEY ARE TRUE LOESSIAL HILLS WITH CLOSE SETTING AND SLOPES SO STEEP THAT THE COMBINES IN PLACES CANNOT TRAVERSE THEM. LOOKS MUCH LIKE AGGRAVATION BUT DIFFERS FROM THAT EAST OF UMATILLA IN THAT THERE ARE NO SAND-COVERED AREAS TO THE SW; I.E. THE WINDWARD.

I THINK THAT THE PLATEAU CAN BE MAPPED TO SHOW THE LOESS HILL TRACTS, THE TRACTS WITHOUT HILLS AND THE SOURCE AREAS OF THE LOESS. SOURCE AREAS WOULD BE THE RIVER VALLEYS AND EXPOSURES OF THE ELLENSBURG FORMATION, PRESUMABLY.

WALLA WALLA TO SPOKANE JULY 17 1926  
IF EVER A PROFESSIONAL LANDSCAPE PHOTOGRAPHER CAN BE INDUCED TO COME INTO THIS FIELD TO

PHOTOGRAPH SCABLAND, THE PLACE TO TAKE HIM WILL BE ON THE HIGH ROAD FROM STARBUCK TO LYONS FERRY. A SIMPLY MAGNIFICENT DISTANT VIEW MAY HERE BE OBTAINED, WITH PROPER LIGHTING AND LENSES AND FILTERS.

THE PALOUSE SCABLAND TRACT BETWEEN LYONS FERRY AND WASHTUCNA IS WONDERFUL! I THINK I NEED NEVER HESITATE AGAIN ABOUT GOING INTO SUPERLATIVES IN DESCRIBING THE GASHED AND CANYONED CHARACTER OF THE SCABLAND, THE SPECTACULARITY OF THE ISOLATED HILLS OF LOESS OR THE STRIKING LOESSIAL BLUFFS WHICH BOUND THIS BROAD TRACT. THERE ARE MANY SMALLER SPILLWAYS AMONG THE HILLS, AND MANY ISOLATED HILLS NEAR THE WESTERN EDGE THAT I HAVE <sup>NOT</sup> MAPPED. THE SHEEP RANCH MIDWAY BETWEEN WASHTUCNA AND LYONS IS AT THE HEAD OF A GREAT CANYONED TRACT THENCE DOWN TO THE SNAKE SW BY S OR NEARLY S.

EVERY WHERE IS A PASSAGE FOR WHICH THERE IS NO EQUIVALENT EXPLANATION AT PRESENT.

THESE EXTEND AS FAR NORTH AS THE SNAKE RIVER SCHOL.

SCABLAND GRAVEL CAST BACK INTO THE VALLEYS AMONG THE LOESSIAL HILLS AT THE TOPMOST BRINK OF THE SCABLAND ALONG WASHTUCNA COULEE. THIS IS ALONG THE ROAD NORTH INTO THE COULEE, WEST OF WASHTUCNA.

A REALLY EYE-OPENING VIEW OF SCABLAND IS DISPLAYED ALONG THE HIGHWAY FROM WASHTUCNA TO RALSTON. IT IS WELL SHOWN ON THE WASHTUCNA SHEET. IT MUST BE SEEN FROM THE SOUTH. A GREAT WIDE STAIRCASE OF BASALT LEDGES OVER WHICH THE TORRENT CASCADED IN MAGNIFICENT GRANDEUR. SCARPING THE LOESS ON EACH SIDE AND YET FAILING TO CLEAN OFF ALL THE LOESS.

CLEARLY THERE ARE FINER SEDIMENTS THAN GRAVEL, BORN OF THE SPOKANE FLOOD, IN THE TUCANNON VALLEY ABOVE STARBUCK. IN THE TRIANGLE FORMED BY THE PATAHA, THE TUCANNON AND THE HIWAY (OR BETTER, IN THE WIDER PLACE FORMED BY JCT OF THE TWO STREAM VALLEYS) ARE SEDIMENTS OF SILT AND BLACK SAND, LENSLIKE AND IRREGULAR BUT DOMINATED BY HORIZONTAL LINES, THAT CONTAIN NON-BASALT FRAGMENTS IN THE BLACK SAND AND THEREFORE COULD ONLY HAVE COME UP THE VALLEY. ALT OF THESE SEDIMENTS, WHICH CONSTITUTE ERODED TERRACES, IS CLOSE TO 1000, PERHAPS BETWEEN 950 AND 1000 IS BETTER. THIS IS LOWER THAN THE SCABLAND FLOOD'S UPPER LIMIT.

EXISTENCE OF THESE FINE SEDIMENTS DEMANDS TIME FOR THE SILTING, TIME THAT WILL RUN INTO YEARS ANYWAY. SPASMODIC ACTION OF THE VOLC. CENTER, IF THERE WERE SUCH, MIGHT FIND ITS RECORD IN SUCH SEDIMENTS. A TEMPORARY LAKE, DAMMED BY THE GREAT GRAVEL DEPOSITS IN THE LOWER STARBUCK, WOULD BE A BETTER EXPLANATION.

THREE OR FOUR FINE ISLANDS OF LOESS STAND ON THE STAIRCASE AT DIFFERENT LEVELS OR STEPS OR EXTENDING ACROSS TWO OR THREE STEPS.

THE WASHTUCNA SHEET SHOWS A DESCENT OF 350 FEET IN 3 1/2 MILES OVER THESE STAIRCASE CASCADES. THIS IS PRECISELY 100 FEET TO THE MILE. MEASURED FROM THE LIP OF THE UPPER CASCADE TO THE HEAD OF THE GRAVEL DEPOSIT, 1300 FT. A.T. THE DEPOSIT IS A TERRACE, NOT A BAR, AND MARKS APPROXIMATELY THE UPPER LIMIT OF THE FLOOD IN WASHTUCNA COULEE UNLESS THERE WAS A DEEP WATER CURRENT OVER THE TERRACE. AT DEVILS CANYON, THE HIGHEST LEVEL REACHED BY THE FLOOD WAS BETWEEN 1300 AND 1350. THE GRADIENT OF THE FLOOD IN WASHTUCNA COULEE COULD NOT HAVE BEEN VERY MUCH FOR THE HIGHEST STAGE OF THE WALLULA PONDING, WHEN THIS GRAVEL PRESUMABLY WAS DEPOSITED. PERHAPS THE DEPTH OF WATER OVER THE GRAVEL COULD BE OBTAINED BY A FIELD EXAM. OF THE ALTITUDE OF SCOURLED LEDGES ON BOTH SIDES OF THE FILL. ANYWAY, THE FLOOD WAS AT LEAST 300 FEET DEEP IN WASHTUCNA COULEE AT THE TOWN OF WASHTUCNA.

SINCE THIS GRADIENT OF 100 FEET PER MILE IS THREE TIMES THE AVERAGE (MORE NEARLY FOUR TIMES) FOR THE SCABLAND TRACT TO THE EAST (COW CREEK CHANNEL) AND THE STAIRCASE CASCADE TRACT IS BUT A LATERAL WHICH BRANCHES OFF AND REJOINS WITHIN SEVEN OR EIGHT MILES, THE PHENOMENON CLEARLY RECORDS A VERY TURBULENT MAIN TORRENT IN WHICH HIGH VELOCITY AND LARGE VOLUME PRODUCED A MOMENTUM THAT PILED THE SURFACE OF THE WATER UP IN PLACES MUCH HIGHER THAN ELSEWHERE IN THE SAME CROSS-SECTION. GRAVITY WAS UNABLE TO PRODUCE A LEVEL TRANSVERSE SECTION OF THE COW CREEK TORRENT. THE WATER SURGED UP ON THE WEST HIGH ENOUGH TO BREAK ACROSS AND MAKE THE STAIRCASE CASCADE.

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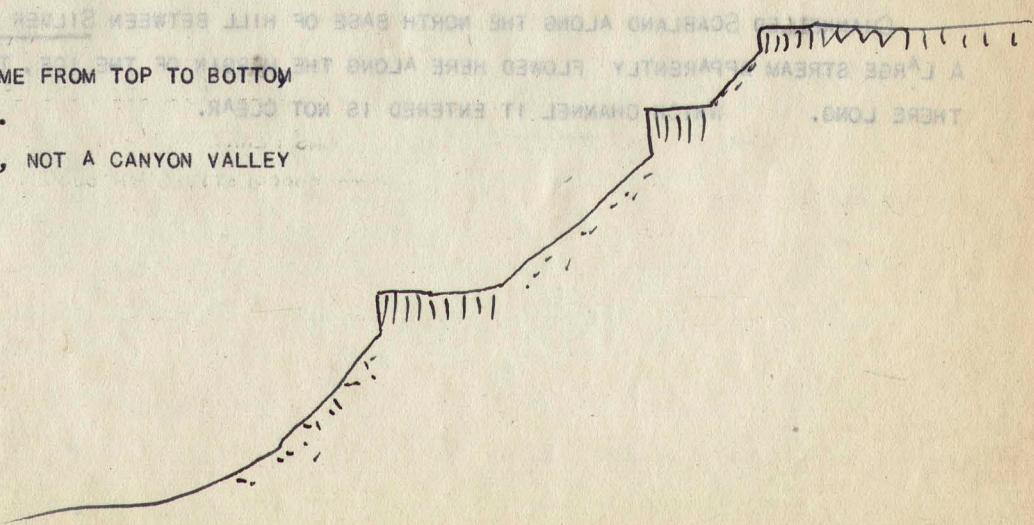
NO LOESSIAL HILLS THENCE TO RALSTON AND, INDEED, NONE OF PRONOUNCED CHARACTER THENCE TO SPOKANE. THE TRACT BETWEEN RALSTON AND RITZVILLE HAS PLENTY OF ~~THE~~ LOESS BUT THE PATTERN IS COARSE-TEXTURED, NOT LIKE THE LOESSIAL HILLS.

VERY GOOD SCABLAND SOUTH OF SPRAGUE (COLVILLE) LAKE WITH PLENTY OF ISLANDS OF LOESSIAL HILLS ALREADY DESCRIBED AND MAPPED. THE IMPRESSION GAINED AFTER A RE-SURVEY IS THAT NONE OF MY PUBLISHED DESCRIPTIONS DO JUSTICE TO THE PHENOMENA. NO DANGER OF OVER-DESCRIBING IT.

RATIO OF TALUS TO CLIFF THE SAME FROM TOP TO BOTTOM.

HENCE ALL CLIFFS THE SAME AGE.

HENCE THE WALL OF A CHANNEL, NOT A CANYON VALLEY



VICINITY OF SPOKANE JULY 20 1926

THERE IS REAL SCABLAND; CLIFFED, MESAD, BUTTED, BASINED, ALONG THE MARGIN OF SPOKANE VALLEY ON THE INDIAN AND FOUR MOUND PRAIRIE MARGINS. IT IS A MILE OR SO IN WIDTH AND DOES NOT LIE ON THE VALLEY SLOPES. IT IS PART OF THE PRAIRIE SURFACE. BUT THIS IS ABOUT ALL. THE BROAD EXPANSE OF THE BASALT PLAIN HAS A FEW ROCK KNOBS HERE AND THERE, AS AT WOODS LAKE AND HORSESHOE LAKE, BUT THESE ARE NOT CLIFFED AND LOOK MORE RUBBED BY ICE THAN PLUCKED BY STREAM ACTION.

COULD THIS CHANNELLED SCABLAND BE THE PRODUCT OF A SUBGLACIAL ESCAPE WHICH WAS GUIDED BY THE SPOKANE VALLEY BENEATH? IT CONTINUES IN MORE OR LESS DEFINITE FASHION TOWARD OR TO THE MARSHALL VALLEY WHERE A SUBGLACIAL DISCHARGE WAS POSTULATED.

REAL MORAINE, MOUNDED AND KETTLY, IN THE HEADS OF THE CHANNELS NORTH OF CHENEY AND AT MEDICAL LAKE CHANNEL WEST OF THE MED. LAKE CHANNEL SEEMS TO HAVE BEEN CLEANED OUT BY WATER FOR A MILE OR TWO NORTH OF THE HEAD, BACK ON THE BASALT PLAIN, AS THO WATER CROSSED TO THE HEAD OF THE CHANNEL LATE IN THE EPISODE AFTER THE ICE EDGE HAD RETREATED SOMEWHAT.

THE STRIKING THING IS THAT THESE WELL-MARKED CHANNELS, WITH SCARPS CUT IN THEIR GRANITE SLOPES AND SOME WITH SCARPS AROUND THE NORTH ENDS OF THE INTERCHANNEL HILLS, SHOULD CARRY MORAINE ACROSS THEIR HEADS. FOR NO WATER COULD USE THESE CHANNELS AND SPARE THE MORAINES.

LOCAL RELIEF OF MORAINE IS ABOUT 25-30 FEET. THICKNESS UNKNOWN. ONE EXPLANATION IS THAT MORAINE IS YOUNGER THAN THE CHANNEL OCCUPANCY. ANOTHER IS THAT ALL THE WATER CAME OVER THE SURFACE OF THE ICE AND THE FRONT HELD ITS OWN. THE LATTER EXPLANATION IS DEFECTIVE IN THAT ESCAPING GLACIAL WATERS <sup>were required to</sup> ERODED GRANITE AND BASALT IN THESE CHANNELS AND <sup>allowed to</sup> NOT EBOODE MORAINE OR ICE AT THEIR HEADS.

MORAINE MIGHT BE YOUNGER AND YET SPOKANE IN AGE. THE SUBGLACIAL VULCANISM HYPOTHESIS PERMITS THE ICE SHEET TO REMAIN AFTER THE FLOOD. THE MELTING OF A BIG HOLE TO THE NORTH WOULD HAVE LITTLE EFFECT ON THE MARGIN OR ON THE MAIN BODY OF THE ICE.

THAT THE BASALT PLAIN IS A GLACIATED PLAIN IS CLEARER THAN EVER <sup>IN MY MIND</sup>. BUT THERE ARE NO GOOD SCARPS IN THE MARGINING PALOUSE AND GRANITIC HILLS NORTH OF HITE AND THERE SHOULD BE IF THE ENTIRE PLAIN <sup>WAS</sup> ONCE COVERED AND THIS PORTION HAS HAD ITS PALOUSE HILLS SCRUBBED OFF.

THE MAMMOTH REPORTED BY HUNGATE LIES A FEW MILES WEST OF CHENY, IN THE PALOUSE HILLS, BURIED IN LOESS. FREEMAN HAS FOUND TWO ROCK FRAGMENTS ASSOCIATED, A GRANITE PEBBLE AND AN ANGULAR PIECE OF SCHIST. MAMMOTH LIES WITHIN A PLOW DEPTH ON A NORTH-PROJECTING SPUR ALONG THE EAST SIDE OF ONE OF THE AMPHITHEATERS WHICH OCCUR ON THE NORTH SIDE OF THESE PALOUSE HILLS.

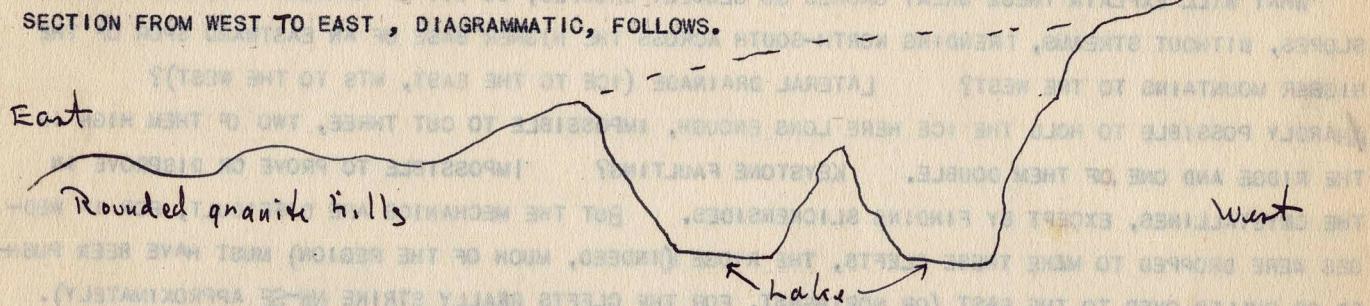
CHANNELLED SCABLAND ALONG THE NORTH BASE OF HILL BETWEEN SILVER LAKE AND GRANITE LAKE. A LARGE STREAM APPARENTLY FLOWED HERE ALONG THE MARGIN OF THE ICE, THO IT COULD NOT HAVE BEEN THERE LONG. WHICH CHANNEL IT ENTERED IS NOT CLEAR.

HORSESHOE LAKE-TROUT LAKE-SACHEEN LAKE JULY 21 1926

ALL THE LAKES IN THIS REGION, FRM ELOIKA (BLAKE'S) TO DIAMOND, ARE BEYOND THE WISCONSIN TERMINAL MORaine. THEY LIE IN DEPRESSIONS WHOLLY OR PARTLY IN ROCK, EXCEPT DIAMOND FOR WHICH SEE 1925 NOTES. THEY ARE ALL CONSEQUENCES OF THE SPOKANE GLACIATION. VERY MUCH BARE GRANITE AND CRYSTALLINES, ELSEWHERE IS SPOKANE DRIFT WH CH IS SANDY AND GRAVELLY ALL THRU HERE. NO REALLY STRIATED SURFACES BUT GRANITE KNOBS ARE STRIKINGLY ROUNDED AND EVIDENTLY REOARD EROSION BY THE SPOKANE ICE. GRANITE IS GNESSOID OR FOLIATED. THIS SHOWS BEST UNDER WEATHERING. MUCH SLABBY DEBRIS; LARGE SLABS AND SHELVES IN THE LEDGES.

NO WISCONSIN ICE OR WATER HAS TOUCHED THIS REGION AND THE TOPOGRAPHY IS WHOLLY THE PRODUCT OF PRE-SPOKANE AND SPOKANE PROCESSES AND EVENTS. WHEN THIS FACT IS APPRECIATED, THERE ARE CERTAIN EXTRAORDINARY FEATURES TO BE CONSIDERED.

HORSESHOE LAKE CARRIES A HIGH ROCK PENINSULA WITH VERY STEEP SLOPES. THE EAST AND WEST SIDE OF THE LAKE ARE LIKEWISE VERY HIGH AND PRECIPITOUS, UTTERLY UNSCALABLE IN MOST PLACES. ON THE EAST THE CLIFFS ARE AT LEAST 300 FEET ABOVE THE LAKE AND ON THE WEST, STILL HIGHER. A CROSS-SECTION FROM WEST TO EAST, DIAGRAMMATIC, FOLLOWS.



ON THE EAST WALL, MORE THAN HALF WAY DOWN TO THE LAKE, IS A GREAT POTHOLE IN THE GRANITE (GRANODIORITE?) ABOUT 40 FEET ACROSS AND OF UNKNOWN DEPTH. IT WAS MADE WHEN, OR AFTER, THE REMARKABLE BORGE WHICH CONTAINS THE LAKE WAS CUT. CLEARLY NOTHING BUT GLACIAL WATERS WERE CONCERNED IN ITS MAKING.

THE EAST WALL IS IN PART A HILL WTH GENTLER SLOPE WAY FROM THE LAKE. ITS PROFILE, CONTINUED WESTWARD, WOULD NOT FALL FAR SHORT OF JOINING THE GENTLER UPPER SLOPES OF THE MOUNTAIN TO THE WEST. THE LOWER ~~WALL~~ STRONGLY RUBBED GRANITE HILLS TO THE EAST ARE TAKEN TO BE LARGELY PREGLACIAL AND MODIFIED ONLY BY ICE ITSELF.

BUT THE GORGE ITSELF HAS BEEN CUT BY WATER INTO THE FLAKS AND PARALLEL TO THE LENGTH OF THE MT. (N-S), OR IT HAS BEEN AT ANY RATE OCCUPIED BY WATER. IT MAY BE CLAIMED THAT THIS IS A KEYSTONE FAULT VALLEY, AND THERE WOULD BE LITTLE CHANCE OF DEMONSTRATING THE CONTRARY. BUT THE INTERPRETATION MOST IN HARMONY WITH ALL OTHER EVIDENCE IS THAT GLACIAL WATERS ERODED IT. AND TO DO THIS SEEMS CLEARLY TO DEMAND SOMETHING ELSE THAN LATERAL DRAINAGE BETWEEN MOUNTAIN TO THE WEST AND ICE TO THE EAST.

ANOTHER EXTRAORDINARY GROUP OF GORGES IS ~~ABOUT~~ THREE MILES NORTH OF THE WEST END OF SACHEEN LAKE, AT THE Y IN THE ROAD SHOWN ON MAP. HERE IS A GRANITE AND CRYSTALLINE ROCK RIDGE PROJECTING EASTWARD FROM THE MAIN MOUNTAIN MASS OUT INTO THE LOWER COUNTRY. IT IS CUT TO THE VERY BASE BY THREE GREAT CLEFFS, THE EASTERN ONE OF WHICH IS USED BY THE ROAD TO CALISPEL LAKE. THE WESTERN NOTCH OR CLEFT IS PROBABLY MORE THAN 300 FT DEEP AND HAS PRECIPITOUS SIDES. NO STREAM IN IT, VERY NARROW AT THE BOTTOM. THE MIDDLE NOTCH IS HARDLY A QUARTER OF A MILE TO THE

EAST AND IS SIMILAR IN DIMENSIONS AND PROPORTIONS EXCEPT THAT IT IS DOUBLE AT THE BOTTOM, A PRECIPITOUS ROCKY HILL RISING MORE THAN 100 FEET IN THE MIDDLE. EACH MEMBER OF THE DOUBLE CLEFT IS EQUALY NARROW, NEITHER POSSESSES A STREAM. BOTH OF THESE BIG CLEFTS OCCUR IN A HIGH PART OF THE RIDGE AND THERE IS NO SUGGESTION OF PREGLACIAL SLOPES OF THE CREST LINE TOWARD THEM.

THE EASTERN CLEFT IS NOT MUCH MORE THAN 100 FEET DEEP THO ITS BOTTOM IS AS LOW AS THAT OF THE OTHER TWO. IT IS HALF TO THREE QUARTERS OF A MILE FROM THE MIDDLE CLEFT AND ITSELF IS RATHER MORE LIKE A GORGE, FOR IT IS  $1/4$  TO  $1/3$  OF A MILE LONG WHILE THE OTHERS ARE SHORT. ALSO THERE ARE GENTLER SLOPES OF THE CREST LINE TOWARD IT, LONGER ON THE WEST SIDE. THERE IS NO STREAM IN THIS CLEFT. IT WAS SEEN AND BRIEFLY DESCRIBED IN 1925 (Aug 1925)

THE COUNTRY TO THE NORTH OF THESE CLEFTS IS LOW FOR SOME DISTANCE. A FLATTISH TRACT, PART SWAMP, PART GRAVEL AND DRIFT, ABOUT A MILE WIDE, STRETCHES TWO MILES OR MORE TO THE NORTH TOWARD CALISPEL LAKE VALLEY. THE FACE OF THE E-W RIDGE CUT BY THE NOTCHES IS AS PRECIPITOUS TOWARD THIS LOW TRACT, AT LEAST IN PLACES, AS ARE THE WALLS OF THE NOTCHES OR CLEFTS. TO THE SOUTH OF THE RIDGE IS A VALLEY ABOUT A MILE WIDE WHICH LEADS OUT TO THE EAST. IT CONTAINS A LARGE DRIFT TERRACE SOUTH OF THE NOTCHES BUT IS LOW CLOSE TO THE BASE OF THE RIDGE.

WHAT WILL EXPLAIN THESE GREAT GASHES SO CLOSELY GROUPED, SO OUT OF HARMONY WITH ALL OTHER SLOPES, WITHOUT STREAMS, TRENDING NORTH-SOUTH ACROSS THE HIGHER BASE OF AN EASTWARD SPUR OF THE HIGHER MOUNTAINS TO THE WEST? LATERAL DRAINAGE (ICE TO THE EAST, MTS TO THE WEST)?

HARDLY POSSIBLE TO HOLD THE ICE HERE LONG ENOUGH, IMPOSSIBLE TO CUT THREE, TWO OF THEM HIGH IN THE RIDGE AND ONE OF THEM DOUBLE. KEYSTONE FAULTING? IMPOSSIBLE TO PROVE OR DISPROVE IN THE CRYSTALLINES, EXCEPT BY FINDING SLICKENSIDES. BUT THE MECHANICS ARE DIFFICULT, FOR IF WEDGES WERE DROPPED TO MAKE THESE CLEFTS, THE RIDGE (INDEED, MUCH OF THE REGION) MUST HAVE BEEN PUSHED OR PULLED OVER TO THE EAST (OR NORTHEAST, FOR THE CLEFTS REALLY STRIKE NW-SE APPROXIMATELY). FURTHER, THE KEYSTONES SHOULD NOT LOGICALLY BE LIMITED TO THIS SHARP RIDGE BUT SHOULD SHOW UP IN THE HIGHER MOUNTAIN SIDE TO THE NORTHWEST. PERHAPS THEY DIE OUT ENOUGH ACROSS THE VALLEY TO THE NORTH. AND BY THIS HYPOTHESIS, IT IS DIFFICULT TO EXPLAIN THE PRECIPITOUS SLOPES OF THE RIDGE IMMEDIATELY ADJACENT TO THE TWO WESTERN NOTCHES, FACING THE BROAD LOW VALLEY, FOR THEY CANNOT BE FAULT SCARPS OF THE KEYSTONE FAULTING.

THE PROBABILITIES SEEM TO FAVOR THE SUBGLACIAL GREAT STREAM HYPOTHESIS. AND THESE NOTCHES ARE NOT FAR FROM NORTH OF THE TWO GASHES AT HORSESHOE LAKE, ABOUT 6 MILES DISTANT. (They are north east)

IF IT CAN BE SHOWN THAT THE FOUR NOTCHES IN THE RIDGE SOUTH OF DIAMOND LAKE ARE OF THE SAME PHYSIOGRAPHIC CHARACTER AND RELATIONSHIP AS THESE, THE CASE FOR SUBGLACIAL WATERSSOUTH-FLOWING HERE WILL BE GREATLY STRENGTHENED.

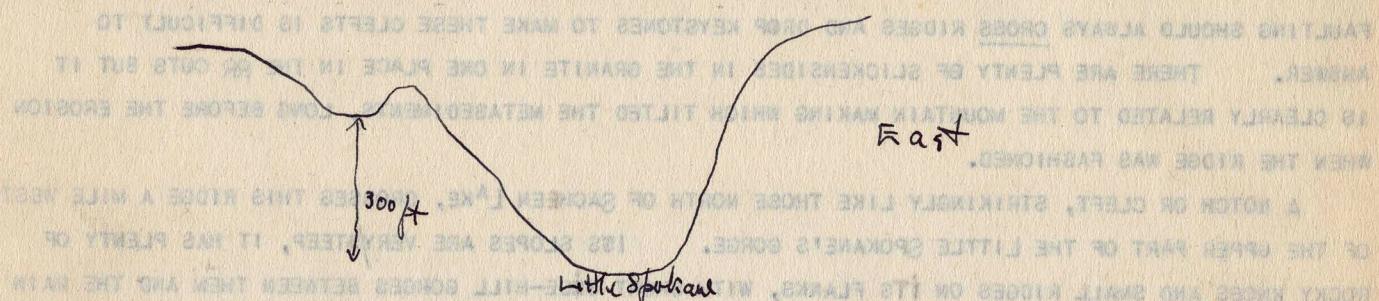
#### VICINITY OF SCOTIA AND CAMDEN JULY 23 1926

THE GORGE FOLLOWED BY THE LITTLE SPOKANE RIVER AND THE G.N.R.R. BETWEEN THESE TWO STATIONS IS  $2 \frac{1}{2}$  TO 3 MILES LONG. ITS WALLS ARE EXCEEDINGLY PRECIPITOUS, THO TALUS HAS CLIMBED CONSIDERABLY. HEIGHT OF CLIFFS ABOVE THE VALLEY BOTTOM VARIES CONSIDERABLY FOR THE GORGE IS VERY CLEARLY CUT ACROSS AN OLDER TOPOGRAPHY, BUT AN AVERAGE HEIGHT WOULD BE ABOUT 300 FT. THE OLDER TOPOGRAPHY IS NOT A VALLEY IN WHICH THE YOUTHFUL GORGE HAS BEEN ENTRENCHED. IT IS THE IRREGULAR CREST LINE OF A FAIRLY BROAD RIDGE OR DIVIDE, WITH HILLS ON IT 300 FEET OR SO IN HEIGHT ABOVE THE SADDLES. THE GORGE IS ESSENTIALLY IN A SADDLE THO IT SWINGS HARD AGAINST THE HILLS

ON THE EAST SIDE AND THERE THE CLIFFS ARE HIGHER.

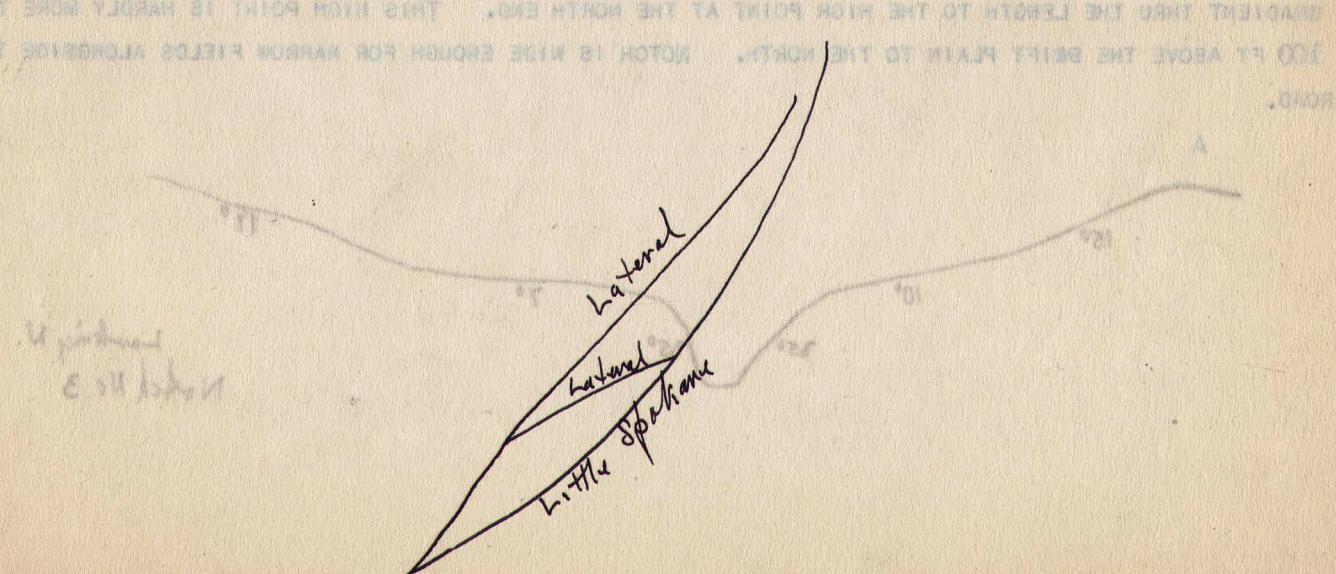
THE PROBLEM OF THE ORIGIN OF THE GORGE IS ADMITTEDLY DIFFICULT BUT SURELY THE EXPLANATION LIES IN THE EVENTS OF THE SPOKANE GLACIATION, FOR WISCONSIN WATERS FOUND THE GORGE ALREADY THERE AND POURED THE VALLEY TRAIN THRU IT. IT IS DIFFICULT TO PUT ANY STREAM ACROSS THE RIDGE HERE AND HOLD IT HERE UNTIL THE GORGE WAS DEEP ENOUGH TO HOLD ITS DRAINAGE LINE AFTER THE ICE RETREATED. BUT IT IS ESPECIALLY DIFFICULT TO GET SEVERAL STREAMS TO DO THIS. AND SEVERAL STREAMS DID! THERE ARE AT LEAST TWO OTHER SUCH WITHIN THREE MILES TO THE WEST OF THE LITTLE SPOKANE. THE LITTLE SPOKANE IS PECULIAR, VERY PECULIAR, IN ANOTHER RESPECT. INDEED, IT SEEMS INEXPLICABLE IN TERMS OF GLACIAL STREAMS ESCAPING FROM A MELTING ICE FRONT OR FROM A POND IN FRONT OF SUCH A SHEET. THE PECULIARITY COMES TO LIGHT ONLY WHEN THE WESTERN CLIFF IS CLIMBED.

AT THE TOP OF THE CLIFF, BUT NOT THE SUMMIT OF THE RIDGE, IS A SMALL GORGE, CARVED IN GRANITE, FROM 20 TO 120 FEET DEEP, PARALLEL OR SUBPARALLEL TO THE MAIN GORGE, AND SEPARATED FROM IT BY A JAGGED, BARE OR NEARLY BARE, ROCK BARRIER FROM 50 TO NEARLY 1000 FEET WIDE, WITH SLOPES ALMOST EQUALLY STEEP TOWARD THE MAIN CANYON AND THE SMALL GORGE.



NOT ALONE THIS, BUT THE WALL BETWEEN THE SMALL PARALLEL GORGE AND THE MAIN CANYON IS CUT THRU OR NEARLY THRU IN A DOZEN PLACES. SOME OF THESE CUTS ARE SIMPLY NOTCHES IN THE WALL, OTHER ARE LITTLE CANYONS. THE DEEPEST OF THESE, HOWEVER, DRAINS BACK INTO THE LATERAL AND CANNOT THEREFORE BE DUE TO WATER ESCAPING OVER TO THE MAIN CANYON FROM THE SUBPARALLEL SMALL GORGE. THE LATERAL GORGE IS SWAMPY AND FLATFLOORED. THE ROCK KNOBS AND RIDGES WHICH CONSTITUTE THE WALL ARE GREATLY SCOURED BUT THERE IS NO EVIDENCE OF GLACIAL ROUNDING SUCH AS THE GRANITE SHOWS ELSEWHERE.

THIS LATERAL CANYON APPARENTLY DOES NOT HAVE ANY ENTRANCE INTO IT AT THE HEAD FROM THE MAIN CANYON. IT DOES JOIN THE MAIN A MILE, OR A MILE AND A HALF FARTHER DOWN THE LITTLE SPOKANE, THO HERE IT APPEARS THAT IT REALLY JOINS ANOTHER LATERAL WHICH HEADS IN ONE OF THE NOTCHES IN THE SEPARATING WALL.



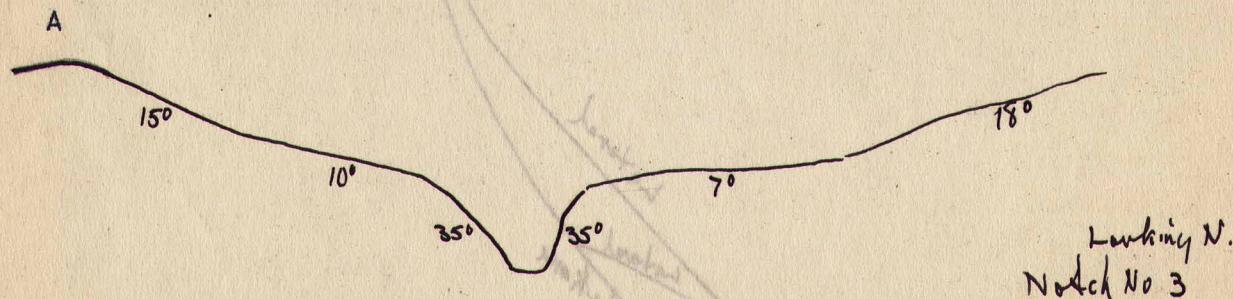
No. 47 at  
summit level  
near  
saddle.  
Thruway.

THERE IS NO GRAVEL AND NO GLACIAL DRIFT IN THIS TRACT. IT IS AS GOOD GRANITE SCABLAND AS IN THE HEAD OF GRAND COULEE, EXCEPT FOR DIMENSIONS. ON THE EAST SIDE OF LITTLE SPOKANE CANYON WHERE THE ROAD CLIMBS OUT THERE IS APPARENTLY ANOTHER MARGINAL TRACT OF SCOURRED HILLOCKS AND RIDGES AND A SMALL LATERAL CANYON. IT WAS SEEN ACROSS THE MAIN CANYON ONLY.

THE ONLY LOGICAL EXPLANATION THAT OFFERS ITSELF FOR THESE FEATURES OF THE LITTLE SPOKANE GORGE IS THAT WHICH SEEKS TO EXPLAIN THE SCABLANDS OF THE COLUMBIA PLATEAU BY SUBGLACIAL VULCANISM. APPARENTLY AN ENGLACIAL RIVER HERE CROSSED THE RIDGE, AND THE LATERAL CANYON AND ITS NOTCHED WALL RECORD THE EARLY FLOOR, BEFORE THE 300-FOOT CANYON WAS ERODED. ROCK SHOULDERED AND SCOURED LEDGES AT THE VERY ENTRANCE TO THE CANYON ARE DIFFICULT TO EXPLAIN OTHERWISE AND FIND AN ADEQUATE EXPLANATION IN THIS CONCEPTION. FURTHERMORE, THERE ARE OTHER NOTCHES CLOSE TO THIS LITTLE SPOKANE AFFAIR AND SIMILAR TO IT IN BEING WHOLLY OUT OF HARMONY WITH THE OTHER RIDGE SLOPES AND CERTAINLY NOT DUE TO EROSION BY GLACIAL ICE. ONLY FAULTING OR THE VAGARIES OF SUBGLACIAL RIVERS SEEMS ADEQUATE. AND WHY FAULTING SHOULD ALWAYS CROSS RIDGES AND DROP KEYSTONES TO MAKE THESE CLEFTS IS DIFFICULT TO ANSWER. THERE ARE PLENTY OF SLICKENSIDES IN THE GRANITE IN ONE PLACE IN THE RR CUTS BUT IT IS CLEARLY RELATED TO THE MOUNTAIN MAKING WHICH TILTED THE METASEDIMENTALS, LONG BEFORE THE EROSION WHEN THE RIDGE WAS FASHIONED.

A NOTCH OR CLEFT, STRIKINGLY LIKE THOSE NORTH OF SACHEEN LAKE, CROSSES THIS RIDGE A MILE WEST OF THE UPPER PART OF THE LITTLE SPOKANE'S GORGE. ITS SLOPES ARE VERY STEEP, IT HAS PLENTY OF ROCKY KNOBS AND SMALL RIDGES ON ITS FLANKS, WITH SHORT SIDE-HILL GORGES BETWEEN THEM AND THE MAIN WALL, A FLOOR THAT IS FAIRLY FLAT FOR A QUARTER OF A MILE OF ITS LENGTH ACROSS THE RIDGE AND A SWAMPY TRACT ON THE HIGHEST OF THE DOWNHILL SLOPE ON THE SOUTH SIDE OF THE CREST. THE CLEFT IS CUT ABOUT AS LOW AS THE ALTITUDE OF THE DRIFT PLAIN TO THE NORTH. IT IS 300 FT HIGHER THAN THE BOTTOM OF THE LITTLE SPOKANE GORGE. THE NOTCH ITSELF MUST BE 300 FT DEEP. AT THE NORTH END, OR ENTRANCE, OF THE NOTCH IS A DEPOSIT OF SPOKANE DRIFT WITH STRIATED BOULDERS. IT LIES A LITTLE LOWER THAN THE FLOOR AT THE HIGH POINT IN THE NOTCH AND THEREFORE DOES NOT CONSTITUTE A DEPOSIT IN THE NOTCH.

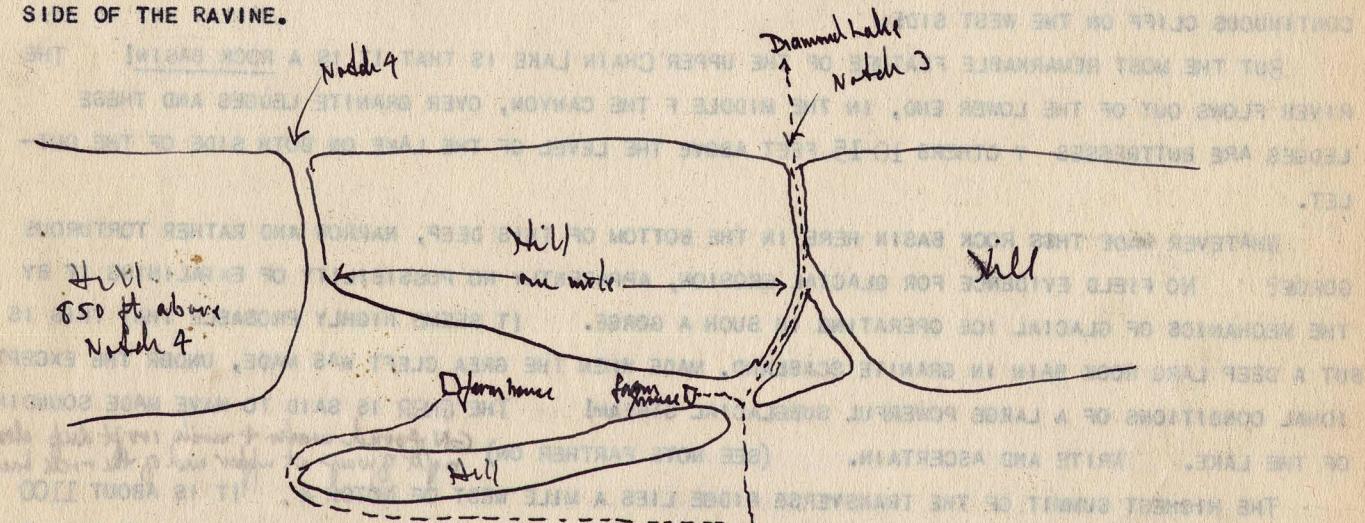
NOTCH NO 3 IS USED BY THE ROAD ACROSS BETWEEN SCOTIA AND CAMDEN. IT IS TWO MILES WEST OF THE LITTLE SPOKANE NOTCH AND AS A CLEFT CUT INTO A SADDLE, IT IS FAIRLY WELL MARBED. ITS SLOPES AND THE JOINING SLOPES SHOW THE SAME CONTRAST AS ELSEWHERE. THE NOTCH IS ABOUT 100 FT DEEP AND HAS SOME ROCKY LEDGES, NOT AS MANY AS IN THE TWO NOTCHES TO THE EAST. A LOW GRADIENT THRU THE LENGTH TO THE HIGH POINT AT THE NORTH END. THIS HIGH POINT IS HARDLY MORE THAN 100 FT ABOVE THE DRIFT PLAIN TO THE NORTH. NOTCH IS WIDE ENOUGH FOR NARROW FIELDS ALONGSIDE THE ROAD.



APPARENTLY STANDING IN THE MOUTH OF THIS NOTCH OR SHORT GORGE IS A ROCK HILL 100 FT OF MORE ABOVE THE NOTCH FLOOR. THE MAIN FLOOR IS ON THE WEST BUT ON THE EAST IS A LOW PLACE 60 FEET BELOW THE MID-HILL SUMMIT, WITH SCOURCED ROCK SURFACES SHOWING IN MOUNDED SHAPES.

ABOUT A MILE FARTHER WEST IS ANOTHER NOTCH (NO. 4) OR SHORT GORGE RIGHT ACROSS THE RIDGE. ITS HIGHEST POINT IN MID-CHANNEL IS 200 FEET ABOVE THE ONE TRAVERSED BY THE ROAD. THERE ARE ROCK LEDGES AND STEEP SLOPES FOR 100 FEET OR SO ABOVE ON EACH SIDE, THE AMOUNT OF DEEPENING IN THE EPISODE WHICH MADE A NOTCH OR SHORT CANYON OUT OF A SADDLE. THE GRADIENT ALONG THIS NOTCH IS LOW AND IT CONTAINS A SWAMPY TRACT THRUOUT ABOUT HALF OF ITS LENGTH, WHICH TOTALS HALF A MILE.

THE SITUATION ON THE SOUTH SIDE OF THE MAIN RIDGE AT THE MOUTHS OF THESE TWO NOTCHES IS BEST PORTRAYED BY A SKETCH MAP. IT LOOKS VERY MUCH AS THO A PREGLACIAL RAVINE HAD BEEN DEVELOPED ALONG THE SOUTH SIDE OF THE MAIN RIDGE, CONTROLLED IN ORIENTATION PROBABLY BY THE LONGITUDINAL STRIKE OF THE METAMORPHOSED SEDIMENTS ASSOCIATED WITH THE GRANITE OF THE RIDGE; AND THE CUTTING OF THE EAST NOTCH HAD INVOLVED THE BREAKING DOWN IN TWO PLACES OF THE MINOR RIDGE ON THE SOUTH SIDE OF THE RAVINE.



THE LOWER LAND OF THE SUPPOSED PREGLACIAL RAVINE HAS A CONSIDERABLE DRIFT DEPOSIT AND SUPPORTS TWO SMALL FARMS. THERE IS NO DRIFT IN EITHER NOTCH.

STILL ANOTHER NOTCH (NOTCH NO 5) IS CUT THRU THIS MUCH-NOTCHED PREGLACIAL DIVIDE BETWEEN THE MTS. ALONG THE IDAHO LINE AND THE COLVILLE MTS. TO THE WEST. IT IS NEARLY OPPOSITE THE MADE BY THE TR HIWAY AND THE ROAD TO SACHEEN LAKE IN THE WEST PART OF THE DIAMOND LAKE FLAT. IT IS NEARLY TWO MILES WEST OF THE MOST WESTERN NOTCH THUS FAR DESCRIBED (NOTCH NO.4). IT DOES NOT SHOW THE NOTABLE STEEPENING IN THE ORIGINAL LONGITUDINAL PROFILE, AT LEAST SO FAR AS SEEN, BUT ITS WALLS ARE STEEP AND IT HAS A REMARKABLE GRANITE SCABLAND OVER ITS WIDE FLOOR. THE LOWEST CHANNEL ACROSS THIS SCABLAND IS ABOUT 200 FEET ABOVE THE DIAMOND LAKE FLAT. THE HIGHER CHANNELS ARE AT LEAST 50 FEET ABOVE. THE TOPOGRAPHY IS CHARACTERIZED BY GRANITE KNOBS, RATHER THAN CHANNELS. CHANNEL WAYS ARE HERE, LEADING FROM NORTH TO SOUTH, BUT THEY ANASTOMOSE CONFUSEDLY. THE KNOBS ARE OF DIFFERENT ALTITUDES, SOME NEARLY OR QUITE 100 FT ABOVE THE LOWEST CHANNEL, AND ONE HAVING A WALL 60 FEET HIGH. THE BARE GRANITE IS VERY MUCH IN EVIDENCE BUT IT DOES NOT SHOW THE ROUND/RODED, WEATHERED ROCHE MOUTONNEE FORMS WHICH ARE CONSPICUOUS A MILE OR SO DISTANT IN THE DIAMOND LAKE DEPRESSION. IT SEEMS IMPOSSIBLE TO EXPLAIN THIS BARE GRANITE IN THE BOTTOM OF THIS NOTCH AS GLACIALLY ERODED. IT IS THE PRODUCT OF A TREMENDOUSLY EFFECTIVE TORRENT WHICH WAS POURED THRU THIS NOTCH UNDER SOME SPECIAL CONDITIONS OF THE SPOKANE EPOCH. THE

CONDITIONS DEMANDED A SIMILAR FUNCTIONING OF EACH OF THE OTHER FOUR NOTCHES ALREADY DESCRIBED. AND THERE APPEARS TO BE A FIFTH (SIXTH?), STILL FARTHER WEST, THO NOT AS FAR AS THE LOW PLACE USED BY THE TR HIWAY IN CROSSING THIS RIDGE. FIVE REMARKABLE STREAM-CUT NOTCHES IN ABOUT 6 MILES OF THE LENGTH OF THIS RIDGE! DOES NOT THIS ESTABLISH THE CONTENTION THAT Z CANYON AND THE NOTCH NE OF NEWPORT (1925 NOTES) ARE OF THE SAME GENESIS AS THOSE IN THE OKANOGAN VALLEY AND THESE FIVE—THAT ENGLACIAL STREAMS OF HUGE SIZE AND TREMENDOUS EROSION ABILITY WERE SOMEHOW BORN OF THE SPOKANE ICE SHEET, TO FEED THE SPOKANE SCABLAND FLOOD, AND DRAGGED ROCK BOTTOM WHERE THAT BOTTOM WAS TRANSVERSELY RIDGED AND FAIRLY HIGH IN THE ICE? <sup>NOTCHES</sup> ~~NOTCHES~~ ~~NOTCHES~~ ~~NOTCHES~~ ~~NOTCHES~~

UPPER CHAIN LAKE, IN LITTLE SPOKANE RIVER, IS WELL WITHIN THE CANYON, THO A MILE FARTHER DOWN THAN THE LATERAL CANYON DESCRIBED ABOVE. <sup>NOTCHES</sup> IT IS VERY DEEP. THE WATER IS CLEAR, YET NO BOTTOM CAN BE SEEN 30 FEET OFFSHORE ALONG MOST OF ITS BORDER. IT IS WALLED BY CLIFF AND TALUS ON THE EAST AND BY ROCK CLIFFS AND ROCK KNOBS ON THE WEST THAT ARE GRANITE SCABLAND, EXACTLY LIKE THAT IN NOTCH 5 AND LIKE THAT 300 FEET ABOVE THE LAKE A MILE OR MORE TO THE NORTH. THERE IS NO CONTINUOUS CLIFF ON THE WEST SIDE.

BUT THE MOST REMARKABLE FEATURE OF THE UPPER CHAIN LAKE IS THAT IT IS A ROCK BASIN! THE RIVER FLOWS OUT OF THE LOWER END, IN THE MIDDLE OF THE CANYON, OVER GRANITE LEDGES AND THESE LEDGES ARE BUTTRESSES BY OTHERS 10-15 FEET ABOVE THE LEVEL OF THE LAKE ON BOTH SIDES OF THE OUTLET.

WHATEVER MADE THIS ROCK BASIN HERE IN THE BOTTOM OF THIS DEEP, NARROW AND RATHER TORTUROUS GORGE? NO FIELD EVIDENCE FOR GLACIAL EROSION, APPARENTLY NO POSSIBILITY OF EXPLAINING IT BY THE MECHANICS OF GLACIAL ICE OPERATING IN SUCH A GORGE. IT SEEMS HIGHLY PROBABLE THAT THIS IS BUT A DEEP LARG ROCK BAIN IN GRANITE SCABLAND, MADE WHEN THE GREAT CLEFT WAS MADE, UNDER THE EXCEPTIONAL CONDITIONS OF A LARGE POWERFUL SUBGLACIAL STREAM! THE GNRR IS SAID TO HAVE MADE SOUNDING OF THE LAKE. WRITE AND ASCERTAIN. (SEE NOTE FARTHER ON) <sup>GN found water + much rock at upper end of the rock basin.</sup>

THE HIGHEST SUMMIT OF THE TRANSVERSE RIDGE LIES A MILE WEST OF NOTCH 4. IT IS ABOUT 1100 OR 1200 FEET ABOVE THE DRIFT PLAIN SOUTH OF DIAMOND LAKE, AND IS 850 FEET ABOVE THE HIGH POINT IN NOTCH 4. IT HAS NO LEDGES ANYWHERE, THO ITS SLOPES ARE VERY STEEP. A FINE-TEXTURED SOIL COVERS THE WHOLE HILL. FROM THE SUMMIT CAN BE SEEN THE BROAD LOW COUNTRY TO THE SOUTH, THE GRANITE HILLS AND THEIR INTERVENING VALLEYS TO THE NORTH, AND THE HIGHER MOUNTAINS TO THE EAST AND THE WEST, WHICH IT CONNECTS. CLEARLY THERE NEVER WAS ANY MAIN DRAINAGE ROUTE ACROSS HERE BEFORE THE REMARKABLE LITTLE SPOKANE CANYON WAS CUT; PROBABLY NO DRAINAGE OF ANY KIND CROSSED.

IN ALL THE GRANITE HILLS TO THE NORTHWARD, THERE ARE NO NOTCHES OR ANYTHING SUGGESTING THEM, IN THE VIEW, EXCEPT THE THREE NOTCHES THREE MILES NORTH OF THE WEST END OF SACHEEN LAKE. TWO OF THESE CAN BE SEEN PLAINLY AND THEIR STEEP SLOPES AND THE SHORT HILL BETWEEN THEM CONTRAST STRONGLY WITH EVERYTHING ELSE IN THE VIEW.

FAULTING AS A CAUSE OF THESE NOTCHES IN THE HORSESHOE-SACHEEN-LITTLE SPOKANE CANYON REGION IS PRETTY WELL OUT OF THE QUESTION. NO FIELD EVIDENCE FOR IT; THE INVARIABLE TRANSVERSE POSITION ACROSS RIDGES; THE NORTH-SOUTH ORIENTATION; THE NOTCH FORM AND ABSENCE OF LONE SCARPS OF ANY KIND; AND THE ~~MUCH~~ VERY MUCH ERODED AND CHANNELLED FORM OF SEVERAL FLOORS, IN SUCH CONTRAST WITH THE GENTLER MOUNTAIN SLOPES WITH CONTINUOUS SOIL MANTLE— ALL INDICATE THAT FAULTING IS NOT RESPONSIBLE.

NOR CAN THE HYOOTHESIS OF LATERAL GLACIAL STREAMS, BETWEEN ICE AND ROCK, EXPLAIN THEM.  
NOR OUTLETS OF GLACIAL LAKES. NO SHIFTING OF ICE MARGIN CAN BE ARRANGED THAT WILL PROVIDE FOR THE DEVELOPMENT OF EACH IN TURN, NOR CAN THEY ALL BE FORMED AT ONE TIME. I AM VERY MUCH INCLINED TO ACCEPT THEM AS PHENOMENA OF THE SPOKANE FLOOD, BUT GENERATED BENEATH AND IN THE ICESHEET BY THE WATERS BEFORE THEY EMERGED TO CROSS THE PLATEAU.

DIAMOND LAKE TO NELSON, B.C.

SUNDAY JULY 25 1926

THE VALLEY OF CLARKS FORK NORTH FROM NEWPORT TO METALINE FALLS IS BENERALLY CAPACIOUS, IN SOME PLACES SEVERAL MILES WIDE. BUT FOR A FEW MILES NEAR RUBY IT IS CONSTRICTED BY LOW MOUNTAINS AND HILLS, THO THE RIVER HERE DOES NOT FLOW OVER ROCK LEDGES. SO FAR AS COULD BE SEEN, THIS IS NOT DUE TO SUPERPOSITION ON A MOUNTAIN SPUR OF THE PREGLACIAL VALLEY BUT IS A REAL CONSTRUCTION OF THE BALLEY. APPARENTLY THE BROAD PORTIONS OF THE VALLEY ARE STRUCTURAL AND THE CONSTRICTED PLACE IS WHOLLY EROSIONAL, PROBABLY BY PREGLACIAL STREAMS.

BUT THE SITUATION AT METALINE FALLS AND Z CANYON IS SO MUCH MORE OF A CONSTRICTION THAT THE CANYONING, THE FALLS AND THE RAPIDS HERE MUST BE DUE TO GLACIAL SUPERPOSITION OF THE PRESENT STREAM ON A PREGLACIAL DIVIDE. THERE NEVER WAS A PREGLACIAL DRAINAGE LINE ACROSS HERE. BOX CANYON, A FEW MILES SOUTH OF METALINE, MAY BE ON A SPUR BUT NOT THE ENSEMBLE NORTH OF METALINE.

HOW MUCH THE RIVER DESCENDS FROM METALINE TO THE MOUTH OF THE CANYONING SOULD BE ASCERTAINED, IF POSSIBLE.

THERE ARE GREAT DEPOSITS OF GLACIAL TILL AND GRAVEL ALONG THE HIWAY NORTH OF METALINE ON THE EAST SIDE OF THE RIVER. THE TRIBUTARIES TO THE PEND OREILLE FORM THIS SIDE ARE SHORT AND HAVE VERY STEEP-WALLED RAVINES CUT IN THE DRIFT.

LITTLE CAN BE SEEN FROM THE ROAD EXCEPT NORTH OF Z CANYON TRAIL. BUT HERE IS A VERY INTERESTING COUNTRY. IT IS CHARACTERIZED BY HIGH HILLS OF ROCK, SEVERAL HUNDRED FEET ABOVE THEIR BASES, VERY STEEP TO PRECIPITOUS, STRONGLY SCOURED BY THE WISCONSIN ICESHEET, SHORT — AND ENTIRELY SEPARATED BROM EACH OTHER BY GORGES OR TRENCHES CUT IN ROCK AND ANASTOMOSING FREELY WITH EACH OTHER. MANY LAKES LIE IN THESE SEPARATING TRENCHES, DUE OF COURSE TO BLOCKING BY DEPOSITS OF WISC. DRIFT. NO ROCK BASINS TO BE RECOGNIZED BECAUSE OF THE DRIFT DEPOSITS ON THE FLOORS. BUT COULD THE WISCONSIN ICE HAVE MADE THIS TRACT OF GASHES, 400 TO PERHAPS 1000 FEET DEEP, AMONG THESE HILLS? COULD THE HILLS HAVE SURVIVED GLACIAL EROSION WHICH MADE THE RELATIVELY NARROW TRENCHES? ORIENTATION OF MAJOR TRENCHES AND ROCK HILLS IS PREVAILINGLY NORTH-SOUTH. NO EVIDENCE THAT STRUCTURAL OR ROCK DIFFERENCES MAY HAVE BEEN THE DETERMINERS. IT SEEMS VERY PLAU- SIBLE THAT TO CONSIDER THESE HILLS AND TRENCHES, HIGH ABOVE THE SALMON TO THE NORTH, AS PRODUCED BY THE SAME EXTRAORDINARY CAUSE WHICH MADE THE NOTCHES SOUTH OF DIAMOND LAKE, BUT FURTHER EXAMINATION MUST BE MADE.

VALLEY OF SALMON RIVER, A TRIBUTARY OF THE PEND OREILLE FROM THE NORTH, JOINS THE MAIN RIVER ALMOST AT  $180^{\circ}$  TO ITS COURSE. AT THE JCT., THE PEND OREILLE TURNS WESTWARD TO JOIN THE COLUMBIA. ON THE MAP, THE SALMON WOULD MAKE A NICE ORIGINAL HEADWATERS OF AN ORIGINALLY SOUTH-FLOWING ~~PEND~~ PEND OREILLE, A LATER DIVERSION HAVING REVERSED THD PEND OREILLE IN THE USA AND TAKEN THE WATER WESTWARD BY A NEW ROUTE.

BUT THE FIELD EVIDENCES ARE MUCH AGAINST THIS INTERPRETATION. THE SALMON VALLEY, AT JCT WITH THE PEND OREILLE, IS A FINE EXAMPLE OF A MOUNTAIN RIVER VALLEY OCCUPIED AND MODIFIED BY GLACIAL EROSION. THIS IS A FEW MILES NORTH OF THE BOUNDARY. THE SALMON'S BOTTOM IS FAR BELOW THE TRENCH FLOORS AMID THE ROCK HILLS, AND APPARENTLY THE PEND OREILLE COURSE BELOW Z CANYON IS THE OLD SALMON. THIS MUST BE RE-EXAMINED HOWEVER.

SIDES OF SALMON VALLEY VERY MUCH SCOURRED AND SPURS CUT AWAY TO STRAIGHTEN THE VALLEY. GRADIENT GENTLE AND UNIFORM. THIS IS TRUE UP THE VALLEY APPROXIMATELY TO YMIR. BUT HERE FOR SEVERAL MILES, THE FLOOR OF THE VALLEY IS DIVERSIFIED BY ROCK KNOBS AND HILLS, APPARENTLY OF GRANITE, THAT STAND AS MUCH AS 100 FEET ABOVE THE STREAM, THAT OBSTRUCT THE VALLEY, THAT CAUSE THE STREAM TO WIND ABOUT AND TO CUT SHORT CHANYONS THRU THEM, AND THAT ARE ALSO DEFLECTED // DEPICTED IN THE WINDING COURSE OF THE GNRR BRANCH LINE TO NELSON.

THERE ARE NO INDICATIONS OF ANYTHING LIKE SIDE-HILL LATERAL GASHES, LIKETHOSE IN THE OKANOGAN COUNTRY. THESE FEATURES ABOVE YMIR ARE ALL IN THE BOTTOM OF THE VALLEY. THEY ARE TAKEN TO RECORD PLUCKING BY GLACIAL ICE IN JOINTED GRANITE.

THE DIVIDE BETWEEN THE KOOTENAY AND THE SALMON HAS BEEN CUT THRU, PRESUMABLY BY ICE FROM THE NORTH, AND NOW CONTAINS LAKES ON THE BROAD COL. THE ASPECT IS VERY SIMILAR TO THAT OF THE NOTCH OR PASS NORTH OF ALADDIN. THE HYPOTHESIS NOW USED CAN NOT HAVE THIS A SUBGLACIAL STREAM NOTCH,

NOTE ON CHAIN LAKES — CHAIN LAKE, ROCK-BASIN BY THE SPOKANE GLACIATION, OCCUPIED AND PRESUMABLY FILLED BY THE WISCONSIN V.T. IS TODAY A BASIN. THIS ANOMALY CAN BE EXPLAINED, HOWEVER BY USING THE DISCHARGE OF LAKE CLARK TO FLUSH OUT THE GRAVEL AFTER THE V.T. CEASED TO GROW. AND THE VOLUME OF LAKE CLARK'S DISCHARGE SEEMS ADEQUATE, IF PUT THRU THIS NARROW PLACE. THE DEEP CHANNEL ACROSS THE PEND OREILLE-LITTLE SPOKANE DIVIDE INDICATES THIS.

NELSON TO ROSSLAND JULY 26 1926

KOOTENAY RIVER FROM NELSON TO COLUMBIA RIVER AT BRILLIANT HAS A LONG SERIES OF CASCADES AND WHITE WATER RIPPLES. THE TOTAL DESCENT IS NOT MORE THAN 375 FEET. THE VALLEY IS NARROW AND THE ROAD IS FORCED TO CLIMB A GOOD DEAL TO FIND A WAY THRU. ALMOST NO TERRACES IN THIS VALLEY. ROCK WALLS ARE VERY MUCH GLACIATED AND SOME MTS SHOW BARE ROCK CLEAR TO THE SUMMIT. A BIT OF TERRACE AT THE BRIDGE BETWEEN NELSON AND BONNINGTON IS COMPOSED OF LAKE SILT. NO SUGGESTION HERE OF THE FEATURES ASCRIBED TO SUBGLACIAL STREAMS.

COLUMBIA VALLEY FROM CASTLEGAR AND BRILLIANT TO TRAIL HAS ONE LONG SUCCESSION OF TERRACED BENCHES. TWO CLEARLY MARKED BENCHES, THE LOWER OF WHICH ABOUT BRILLIANT IS EXTENSIVELY ORCHARDED BY THE DOUKHOBORS. BUT THIS IS ABOUT ALL THE CULTIVATION ON THEM. GRAVEL VENEER ON BOTH TERRACE TOPS BUT A GOOD SECTION ON EAST SIDE OF THE COLUMBIA A FEW MILES NORTH OF TRAIL SHOWS LAKE SILT FROM BOTTOM 1/2 OF VALLEY TO THE TOP OF THE HIGHEST TERRACE.

THE EAST WALL OF COLUMBIA VALLEY FROM KOOTENAY JCT. TO TRAIL, SHOWS GREAT ALIGNED STEEP FACES OF ROCK, MUCH OF IT BARE, WITH HERE AND THERE A TRIBUTARY HANGING VALLEY AND, WHERE IN PROFILE, THE OFT-CITED GLACIAL STEEPENING FROM THE OLD EROSION PROFILE AND THE U-SHAPED CONCAVE FLATTENING AT THE LOWER TERMINUS. NOTHING WAS SEEN OF THE FEATURES ASCRIBED TO SUBGLACIAL STREAMS.

mt valley

ON THE WEST SIDE, A GROUP OF SPECTACULAR CLIFFED HILLS OR ALMOST PINNACLES WITH HUGE CLEFTS SEPARATING THEM, STAND A FEW MILES BELOW CASTLEGAR. THEY ARE HIGH ON THE VALLEY SLOPE, THO THE NOTCHES ARE VERY DEEP. THEY APPEAR TO CONSTITUTE AN OLD SPUR OF THE INSIDE OF THE CURVE OF THE COLUMBIA VALLEY HERE THAT HAS BEEN VIGOROUSLY TREATED BY GLACIAL ICE OR BY SUBGLACIAL STRMS.

#### VICINITY OF TRAIL JULY 27 1926

THE UPPER TERRACE AT TRAIL IS 1900 FT ABOVE SEALEVEL OR ~~1000~~/540 FT ABOVE THE FLAT ON WHICH THE BUSINESS PART OF THE TOWN IS BUILT. THIS BLAT IS 1364, AND NOT MORE THAN 40 FEET ABOVE THE LEVEL OF THE COLUMBIA. THE LOWER TERRACE, ON WHICH THE SMELTER STANDS, IS 290 FT ABOVE THE TOWN FLAT, OR 1650 AT. BOTH TERRACES ARE COMPOSED OF VERY FINE TEXTURED SAND, VERY WELL SORTED AND WELL BEDDED. GOOD CURRENT BEDDING, A FEW INCHES INDEPTH, MAKES UP MANY OF THE STRATA. A FEW CLAYEY STRATA ARE PRESENT BUT THE THICK DEPOSIT IS MOSTLY GRITTY ~~SILT~~ SILT OR FINE SAND. NO INTERBEDDED GRAVEL RECOGNIZED.

SOME LAYERS IN THE SAND ARE WELL CHARGED WITH CALCAREOUS NODULES. ONE STRATUM, 1/2 INCH THICK IS SO WELL CEMENTED WITH CACO<sub>3</sub> THAT SLABS THREE FEET LONG CAN BE EXCAVATED. MANY CALCAR-EOUS ROOT CASTS.

CLASTIC DIKES OF COARSE GRAVEL IN A FEW PLACES. THEY OCCUR AT DIFFERENT LEVELS AND CLEARLY ARE DUE TO OPENING OF CREVICES AND FILLING FROM ABOVE, THE FILLING MATERIAL BEING DERIVED FROM THE SLOPE, NOT THE TOP. SO WITH THE CALCAREOUS ROOT CASTS—THEY HAVE COME FROM PLANTS GROWING ON THE EROSIONAL SLOPES.

THESE TWO TERRACES ARE PRESENT IN FRAGMENTS ALL THE WAY DOWN TO THE MOUTH OF THE PEND OREILLE. THE UPPER LIMIT OF 1900 IS 200 FEET HIGHER THAN PARDEE'S FIGURE FOR THE NESPELEM UPPER LIMIT. NEVERTHELESS, THE REMARKABLE CONTINUITY FROM THE KOOTENAY TO THE PEND OREILLE AND AGAIN IN WASHINGTON SEEMS TO INDICATE THAT THERE IS ONE GREAT SILT DEPOSIT WHOSE SURFACE RISES GRADUALLY TOWARD THE NORTH.

NEITHER THE PEND OREILLE, THE SALMON OR THE BEAVER CREEK VALLEYS SHOWED THE SILT TERRACES.

PEND OREILLE VALLEY FROM THE COLUMBIA UP TO THE MOUTH OF THE SALMON IS A GREAT GORGE-LIKE AFFAIR; NARROW, STEEP-WALLED, THE RIVER TUMBLING IN MANY RAPIDS AND CASCADES THRUOUT THIS DISTANCE.

MUCH OR MOST OF THIS COURSE IS MARGINED WITH ROCK LEDGES; RIVER CARVED, NOT GLACIATED. INDEED, THE VALEY SHOWS NO GOOD EVIDENCE OF STRONG GLACIATION. THE DESCENT FROM THE MOUTH OF THE SALMON (ABOUT 1700 TO THE COLUMBIA (ABOUT 1300) IS 400 FEET AND THE DISTANCE IS ABOUT 15 MI. THIS WHOLE STRETCH IS VERY YOUTHFUL. IT IS MUCH YOUNGER THAN THE WIDE SALMON VALLEY, WITH ROOM FOR ROAD, RAILROAD, SMALL FIELDS AND HERE AND THERE A TOWN.

FURTHERMORE, THERE IS A TRANSVERSE VALLEY ACROSS FROM SALMO TO COLUMBIA GARDENS, ABOUT 20 MI. LONG, WITH A GRADIENT OF 200 FEET IN 18 MILES, WITH WIDTH FOR FARMS ALL THE WAY, WITH ITS DIVIDE OCCUPIED BY TWO OR THREE LAKES, WITH THE DIVIDE IN IT ONLY FIVE MILES FROM SALMO IN THE SALMON VALLEY AND VERY LITTLE ABOVE SALMO. A THRU VALLEY! IT CAN ONLY BE AN OLD COURSE OF THE SALMON. THE RECONSTRUCTION HERE WOULD TURN SOUTH FORK, LOST CREEK AND SHEEP CREEK NORTHWARD TO SALMO TO JOIN THE SALMON FROM THE NORTH, THE UNITED STREAMS FLOWING THENCE WESTWARD ~~TO~~ TO THE COLUMBIA AT COLUMBIA GARDENS.

WHEN THE ENTRANCE OF THIS OLD VALLEY, NOW OCCUPIED BY BEAVER CREEK, INTO THE COLUMBIA VALLEY IS EXAMINED, IT IS FOUND TO BE REMARKABLY HANGING. IT MOUTHS ABOVE THE LEVEL OF THE HIGH TERRACE, FULLY 550 FEET ABOVE THE COLUMBIA. THIS, THEN, IS A MEASURE OF THE DEPTH OF THE GLACIAL EROSION PERFORMED IN THE COLUMBIA VALLEY HERE. IT IS SURPRISINGLY GREAT BUT ROCK SHOULDER ALONG THE COULMBIA NEAR TRAIL, ABOUT 500 FEET ABOVE THE COLUMBIA, SEEM TO RECORD REMNANTS OF THE PREGLACIAL FLOOR.

CHANGE OF THE PEND OREILLE DRAINAGE TO CROSS THE BARRIER AT METALINE FALLS AND Z CANYON, AND TO FLOW THENCE TO THE COLUMBIA REQUIRES SOME SPECIAL EXPLANATION. THE REVERSAL OF THE SALMON FROM SALMO TO JCT OF SOUTH FORK AND THE JOINING WITH THE PEND OREILLE REQUIRES THE SAME EXPLANATION. WHAT THAT IS, IS NOT CLEAR. IT SEEMS ALTOGETHER TOO FAR FETCHED TO DRAG IN THE SUBGLACIAL RIVER HYPOTHESIS FOR THERE ARE NO GOOD EVIDENCES IN VIEW OF SUCH STREAMS ABOUT TRAIL OR COLUMBIA GARDENS, OR WANITA, OR ALONG THE LOWER PEND OREILLE. THE NORTH WALL OF THE PEND OREILLE VALLEY WAS NOT SEEN, THE DRIFT IS THICK ON THE NORTH SIDE OF THE VALLEY AND THE FOREST COVERS OR LARGELY COVERS EVERYTHING AND OBSCURES THE VIEW.

THE ONLY ITEM TO BE ADDED FROM TODAY'S TRIP REGARDING THE LAKES AND HILLS ABOUT THE CANADA CUSTOMS STATION ON THE NELSON-SPOKANE HIWAY IS THAT CUSTOMS STATION IS ABOUT 2400 ALT., PERHAPS 100 FEET ABOVE THE AVERAGE ALTITUDE OF THE LAKES.

5100 FT. MT. ON BOUNDARY TRAIL EAST OF CANADA CUSTOMS HAS GLACIAL DRIFT <sup>TO THE</sup> ON TOP. BUT THERE SEEMS TO BE NO SHAPING DUE TO GLACIAL OVERRIDING AND THERE ARE NO BARE LEDGES FROM BASE TO TOP.

#### ROSSLAND TO CASCADE JULY 28 1926

VALLEY FROM ROSSLAND TO TRAIL DOES NOT SHOW MUCH GLACIAL EROSION OR SHAPING, EXCEPT NEAR THE COLUMBIA. NO APPARENT HANGING ARRANGEMENT, EITHER.

FIRST SUMMIT WEST OF ROSSLAND IS 4700. SHEEP CREEK VALLEY AT CROSSING OF HIWAY IS 2300. SUMMIT IN HIWAY WEST OF SHEEP CREEK IS 5400. CHRISTINA LAKE IS 1450. GLACIAL TILL OVER EVERYTHING EXCEPT IN THE LOWER PARTS OF THE VALLEYS WHERE THERE ARE NEARLY BARE GLACIATED SURFACES. SHEEP CREEK VALLEY HAS A HEAVILY GLACIATED MT. SPUR, SOUTHPOINTING, CHRISTINA LAKE VALLEY HAS MUCH BARE OR NEARLY BARE ROCK ON ITS STEEP, STRAIGHT BOUNDING SLOPES.

VALLEY OF SUTHERLAND CREEK, EAST OF THE LAKE, IS HANGING AT 500 FT ABOVE THE LAKE SURFACE, INDICATING AT LEAST THIS DEPTH OF GLACIAL EROSION, THO HOW MUCH WAS PRE-WISCONSIN IS DIFFICULT TO SAY.

SILT PROBLEM— NO SILTS SEEN IN SHEEP CREEK VALLEY AND NO TERRACES WHICH MIGHT BE SILT. BUT THE TRIBUTARY VALLEY FROM THE WEST, FOLLOWED BY THE HIWAY, HAS EXPOSURES OF SILT ALONG THE HIWAY CUTS FROM 2700 UP TO 3300. THIS SILT LOOKS EXACTLY LIKE THE COLUMBIA RIVER SILT AT TRAIL BUT IS VERY MUCH HIGHER. NO SILT OR SILT TERRACES SEEN IN CHRISTINA LAKE VALLEY. ALL TERRACES PRESENT ARE SMALL AND IRREGULAR AND SO FAR AS SEEN THEY ARE COMPOSED OF TILL AND GRAVEL. YET THE ALTITUDE IS LOW ENOUGH TO CATCH VIRTUALLY ALL OF THE NESPELEM AS SHOWN AT TRAIL.

NOTCHES AND GASHES— SIDE-HILL GASHES, 200-300 FEET DEEP, AND AS MUCH AS HALF A MILE LONG, ARE CONSPICUOUS ALONG THE HIWAY DOWN THE EAST WALL OF CHRISTINA LAKE VALLEY AT FOOT OF THE LAKE, ANOTHER GREAT SIDEHILL GASH (OR AT ANY RATE, A SIDEHILL RIDGE) LIES NORTH OF FIFE STA. AND TWO OR THREE SMALLER ONES. THE BIG RIDGE IS NARROW AND ALL OF A MILE LONG. ITS PROMINENCE IS STRIKING. WHY SHOULD THEY BE HERE AND NOT ON SHEEP CREEK VALLEY WALLS?

DIVIDE BETWEEN DOG CREEK AND MCRAE CREEK IS A NARROW CANYON WITH VERY STEEP WALLS. AT COR-YELL, THE VALLEY OF MCRAE CREEK IS 1000 FT DEEP AND HARDLY 100 FT WIDE AT THE BOTTOM; ALL OUT OF PROPORTION TO THE TINY STREAM HERE. AT THE DIVIDE IS FLAT MEADOW LAND, ACCORDING TO REPORT. IF SUBGLACIAL WATERS EVER WERE IN ARROW LAKE, THEY MIGHT WELL HAVE COME STRAIGHT SOUTH ACROSS TO THE KETTLE AT CASCADE BY WAY OF THIS DEEPLY NOTCHED DIVIDE. CERTAINLY THE DIVIDE HERE IS WHOLLY UNLIKE ANY OTHER SUMMITS YET SEEN IN THIS DISTRICT. AND IT IS DIFFICULT TO EXPLAIN IT AS DUE TO ICE DIRECTLY.

CHRISTINA LAKE TO GREENWOOD JULY 29 1926

ANOTHER EXAMINATION OF THE SIDE-HILL GASHES ABOUT CHRISTINA LAKE AND CASCADE SHOWS THEM TO BE MUCH LESS MARKED THAN DESCRIBED YESTERDAY. THEY DO EXIST BUT THEY MAY PERHAPS BE DUE TO GLACIAL EROSION. GLACIAL EROSION IN DEEPENING THESE VALLEYS SEEMS TO HAVE LEFT MANY KNOBS NEARLY AS HIGH AS THE ORIGINAL ROCK FLOORS. THIS IS TO BE APPLIED TO SALMON RIVER VALLEY ABOUT YMIR, TO THE COLUMBIA ABOUT TRAIL, TO THE KETTLE VALLEY ABOUT CASCADE AND ESPECIALLY MARKED AT GRAND FORKS, AND TO THE BOUNDARY CREEK VALLEY AT GREENWOOD. PREGLACIAL SLOPES ARE RECOGNIZED ABOVE THE LEVEL OF THE KNOB TOPS BY THEIR GENTLER SLOPE, AND THE FACT THAT THE STRONGLY GLACIATED, BARE, STEEP ALIGNED VALLEY SLOPES ARE SELDOM HIGHER UP THE VALLEY SIDES THAN THE HIGHER OF THESE KNOBS. HANGING VALLEY RELATIONSHIPS ALSO INDICATE THE SAME THING.

THESE SIDE HILL GASHES ARE NOT MUCH HIGHER THAN THE OTHER EVIDENCES OF STRONG GLACIAL EROSION. THEIR FORM, HOWEVER, CANNOT BE AScribed TO CONTROL BY STRUCTURE UNDER GLACIAL PLUCKING OR GRINDING FOR IN THE TWO BETTER ONES, NEITHER JOINTING NOR CLEAVAGE ARE PARALLEL OR EVEN SUB-PARALLEL TO THEIR ELONGATION.

THE LARGEST OF ALL IS IN THE BOSTREAM ANGLE BETWEEN CHRISTINA LAKE VALLEY AND SUTHERLAND CR. VALLEY. IT IS NOT A RIDGE, AS DESCRIBED YESTERDAY, BUT AN EQUILATERAL TRIANGLE. SUMMIT IS 1400 ABOVE THE LAKE AND NOTCH BACK OF IT IS 300 FEET DEEP. THIS NOTCH MAY BE DUE TO NOTHING MORE THAN THE HEADING TOGETHER OF TWO TRIBUTARY VALLEYS, DEEPEened BY GLACIAL EROSION, BUT IT LOOKS TOO MARKED EVEN FOR THIS. THERE IS A ROCK KNOB IN THE MIDDLE OF IT, AND THERE APPEARS TO BE A SMALLER NOTCH OR SIDE HILL GASH A HILL LITTLE HIGHER UP ON THE HIGHLAND SIDE. THIS TRIANGULAR HILL HAS VERY STEEP SLOPES TOWARD THE LAKE, MUCH STEEPER THAN TOWARD THE NOTCH. YET THE SLOPES OF THE NOTCH ARE STEEPER THAN PREVAILING PREGLACIAL SLOPES ABOVE THE CLIFFED PORTIONS OF THE LAKE VALLEY.

AND THE SPUR TO THE NORTH AND THE SPUR TO THE SOUTH BOTH HAVE TWO OR THREE NOTCHED PLACES, WHICH IN THEMSELVES ARE NOT NOTABLE BUT MAY BE SIGNIFICANT WHEN CONSIDERED WITH THIS PARTICULAR 300-FOOT NOTCH.

TERRACES IN KETTLE VALLEY AT CASCADE ARE ALL OF GRAVEL. THEIR ALTITUDES ARE ROUGHLY 1750, 1650 AND 1550. NO SILT TERRACES IN THE REGION. A LONG ROCK SPUR PROJECTS OUT FROM THE NORTH INTO THE KETTLE VALLEY HALFWAY FROM CASCADE TO LAURIER. IT IS CROSSSED BY KETTLE RIVER IN THE VERY NARROW GORGE WHERE THE POWER PLANT IS LOCATED. THE SPUR IS VERY GREATLY ERODED BY GLACIAL ICE.

NO SILTS IN KETTLE VALLEY FROM CASCADE TO GRAND FORKS. GRAVEL TERRACES HERE AND THERE, PARTICULARLY A FEW MILES WEST OF GRAND FORKS. FOUR SUCH TERRACES, EACH SEPARATED FROM THE OTHER BY ABOUT 50' IN ALTITUDE, ALL GRAVEL. THE UPPERMOST IS ONLY A FRAGMENT BUT THE OTHERS ARE VERY EXTENSIVE. SILTS, HOWEVER, OCCUR IN TWO OR THREE TERRACE FRAGMENTS UP THE NORTH FORK OF KETTLE RIVER (GRANBY RIVER) FOR A FEW MILES. THESE SEEM TO INDICATE VERY LOCAL LATERAL PONDS, FOR THE NORTH FORK OR THE MAIN KETTLE CERTAINLY ARE NOT COMPETENT TO HAVE CLEARED ALMOST ALL OF A SILT DEPOSIT FROM THEIR VALLEYS WHILE THE GREAT COLUMBIA, IN A VALLEY NOT WIDER THAN THE KETTLE AT GRAND FORKS, HAS SCARCELY MORE THAN TRENCHED INTO ITS SILT DEPOSIT. THE TERRACES ON THE COLUMBIA MAKE A CONTINUOUS BORDER, EITHER ON ONE SIDE OR THE OTHER OF THE VALLEY.

GRANBY RIVER VALLEY (NORTH FORK KETTLE ) JULY 30 1926

TRAVERSE UP TO THE FORKS OF BURRELL CREEK. RISE IN RIVER LEVEL OF 500 FT FROM GRAND FKS. ISN'T THIS THE RISE OF 500 FT IN 20 MILES ALTOGETHER TOO LOW A GRADIENT FOR ANY VALLEY GLACIER TO ERODE ON? THE GRANBY VALLEY IS TREMENDOUSLY ERODED. THE ABSENCE OF FOREST ON MANY SLOPES BECAUSE OF FIRES, SHOWS THIS FEATURE VERY STRIKINGLY. SEVERELY RUBBED SLOPES ASCEND TO THE VERY SUMMITS OF THE BORDERING HILLS AND MTS., 3000 FT OR SO ABOVE THE STREAM. HANGING VALLEY RELATIONS SEEN IN SEVERAL TRIBUTARIES, INDICATING A GLACIAL DEEPENING OF 500 FT.+, AS FAR UP AS THE BURRELL CREEK FORKS.

THERE ARE SEVERAL THINGS ABOUT GLACIAL EROSION BY AN ICE SHEET RIDING OVER A MOUNTAINOUS MASS THAT I DONT KNOW. ONE VERY CURIOUS ~~THIS~~ SITUATION IS AT AND JUST ABOVE THE JCT OF GRANBY AND KETTLE. GREAT ROCK HILLS SEEM TO FILL THE VALLEY THO THERE ARE PASSES AMONG THEM SO THAT THEY STAND ISOLATED. ONE ESPECIALLY PROMINENT ONE RISES IMMEDIATELY NORTH OR NORTHWEST OF GR.FKS. IT MUST BE 400 FT ABOVE THE TOWN. BETWEEN TWO OTHERS, THE GRANBY ESCAPES IN A NARROW GORGE FROM ITS BROAD OPEN VALLEY FARTHER NORTH. THESE KNOBS HAVE BEEN GREATLY ERODED BY GLACIAL ICE, AND SEEM TO BE REMNANTS OF THE PREGLACIAL FLOOR. IF THIS BE THE CASE, THEN THE BROAD VALLEY ABOVE THESE HALF DOZEN KNOBS AS FAR AS LYNCH CREEK MUST BE A "ZUNGENBECKEN", BY GLACIAL EROSION.

ANOTHER CURIOUS PLACE IS A MILE ABOVE THE JCT OF LYNCH CREEK. HERE THE VALLEY IS SHARPLY OFFSET FOR HALF A MILE OR SO, THE OFFSET BEING VERY NARROW AND THE ROCK SHOULDERS ON EACH SIDE BEING GREATLY GASHED AND ERODED INTO KNOBBY AND PINNACLED SUMMITS. ABOVE THIS CONSTRICKTION IS ANOTHER BROAD VALLEY STRETCH UP TO THE FORKS, LIKE THAT BELOW. ANOTHER "ZUNGENBECKEN"?

THERE SEEKS TO BE NO OTHER LOGICAL EXPLANATION EXCEPT THAT OF STRUCTURAL DEPRESSIONS, AND THERE IS NO EVIDENCE OF THESE IN THIS GREATLY ERODED MT. MASS.

GASHES AND SIDE-HILL NOTCHES OR CLEFTS ARE PRESENT ALONG THE GRANBY BUT MOST OF THEM ARE BELOW THE LEVEL OF MAXIMUM GLACIAL EROSION AND THEREFORE MUST BE ASCRIBED TO PLUCKING IN A CURIOUS FASHION. BUT ON THE MT. SLOPES WEST OF THE FORKS OF THE RIVER, IS A SERIES OF SIDE HILL NOTCHES THAT DO NOT SEEM TO BE OF THIS ORIGIN. THREE GREAT SPURS ARE TRENCHED IN A LINE PARALLEL TO THE VALLEY, THE NOTCH FLOORS BEING ABOUT 700-800 FEET ABOVE THE RIVER AND THE KNOBS OR RIDGES LEFT BETWEEN ~~THE~~ VALLEY AND NOTCHES STANDING 300 TO 800 FEET ABOVE THE NOTCH FLOORS. TWO LAKES SHOWN ON THE MAP IN ONE OF THESE NOTCHES AND TWO TRIBUTARIES ORIENTED PARALLEL TO THE MAIN VALLEY. NOW, THESE NOTCHES ARE CLEARLY GLACIATED BY THE WISCONSIN ICE, CONSIDERABLY RUBBED. BUT WERE THEY MADE BY THE WISC. ICE? THE 800-FT NOTCH SEEMS IMPOSSIBLE TO EXPLAIN THIS WAY. IF SUB-

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GLACIAL VULCANISM IS EVER ESTABLISHED FOR THE SPOKANE EPOCH, THESE NOTCHES WILL BE PUT IN THE CATEGORY OF SUBGLACIAL STREAM COURSES.

VICINITY OF EHOLT IS CONSIDERABLY DIFFERENT FROM THE COUNTRY YET SEEN. IT IS A REGION OF LOW MTS. THAT SEEM ISOLATED OR SEMI-ISOLATED BY UNDULATING LOWER RELIEF, DRIFT-COVERED OR WITH LOW ROCK HILLS. LOOKS LIKE A PREGLACIAL TOPOGRAPHY OF LATE MATURITY ON THE UPLANDS. IT IS A DIVIDE REGION TODAY, ESPECIALLY HIGH BECAUSE OF THE DEEP GLACIAL EROSION IN KETTLE, GRANBY AND BOUNDARY CREEK. THERE HAS BEEN GLACIAL EROSION ON THESE HILLS BUT IT HAS NOT BEEN PRONOUNCED.

BOUNDARY CREEK FROM EHOLT TO WITHIN 8 MILES OF GREENWOOD SHOWS NO VALLEY DEEPENING BY GLACIAL EROSION. THE VALLEY HERE IS NEARLY E-W AND PERHAPS THIS IS THE REASON, FOR THE ICESHEET MOVED ACROSS, RATHER THAN ALONG. BUT THERE IS DEEPENING AND THE PRODUCTION OF ROCK HILLS IN THE VALLEY IN THE LOWER PART OF THE E-W PART, AND THENCE TO GREENWOOD WHERE GLACIAL EROSION HAS BITTEN PERHAPS 300 FT DEEP.

GREENWOOD TO BEAVERDELL JULY 31 1926

A NOTABLE CONSTRICTION IN BDY CREEK VALLEY A FEW MILES BELOW GREENWOOD. THIS IS IN THE GLACIALLY ~~ERODED~~ DEEPESED PORTION AND IS NOT TO BE ATTRIBUTED TO THE PREGLACIAL VALLEY. THE SAME RESTRICTION APPLIES ALSO TO THE GRANBY RIVER CONSTRICTION ~~ABOUT MIDWAY BETWEEN GRAND FORKS AND THE FORKS OF FURRELL AND CREEK AND BRANBY RIVER.~~

BUT THE CHARACTER OF THE VALLEY CHANGES AT BDY FALLS AND ROCK CREEK TOWN. HERE IT RESEMBLES THE VALLEYS IN NORTHERN WASHINGTON, SHOWING NO NOTABLE DEEPENING, BEING CAPACIOUS, HAVING TERRACES OF DRIFT AND GRAVEL; DISCONTINUOUS, NARROW AFFAIRS, ON THE LOWER SLOPES. THESE ARE OF THE SAME GENESIS AS THOSE IN WASHINGTON, BUILT ALONG THE EDGE OF WANING TONGUES OF ICE IN THE VALLEYS.

A PROBLEM WHICH SHOULD BE SOLVED FROM THE FIELD EVIDENCE ARISES HERE. IF THESE B.C. VALLEYS HAVE HAD THE GLACIAL DEEPENING HERE ATTRIBUTED TO THEM, AND IF THE VIGOR OF GLACIAL DEEPENING IS MUCH LESS MARKED ACROSS THE LINE IN WASHINGTON, THERE SHOULD BE SOME RECOGNIZABLE FEATURES TO RECORD THIS. DECREASE IN GRADIENT OF ROCK FLOOR MIGHT EXIST BUT BE CONCEALED BY STREAM GRAVELS AND TILL DEPOSITED DURING THE WANING STAGES. NARROW VALLEYS SHOULD BROADEN DOWNSTREAM. ROCK KNOBS AND ALIGNED STEEPENED SIDES SHOULD DISAPPEAR. HANGING VALLEYS SHOULD DISAPPEAR. SPURS SHOULD BE IN EVIDENCE. ARE THESE THINGS RECOGNIZABLE?

THE MYSTERY OF THE ABSENCE OF SIDE HILL GASHES, NOTCHED SPURS AND CLEFT DIVIDES IS DEEPENING. IF SUBGLACIAL WATERS MADE THEM FARTHER SOUTH, OR EVEN IF LATERAL STREAMS MADE THEM DURING THE WANING STAGES OF THE GLACIATION, WHY SHOULD THEY NOT BE HERE AS WELL AS IN WASHINGTON? ONE POSSIBLE ANSWER IS THAT WISCONSIN GLACIATION WAS SO VIGOROUSLY EROSIVE THAT THEY HAVE BEEN WIPED OUT. ANOTHER IS THAT THE WATERS FROM THE VOLCANIC MELTING WOULD FLOW OVER THE SURFACE INSTEAD OF SUBGLACIALLY, UNTIL NEARER THE MARGIN WHERE THE ICE WAS THINNER AND MORE FISSURED. BUT IN REBUTTAL TO THE LATTER SUGGESTION, IT SHOULD BE CONSIDERED THAT THERE WOULD BE NO MECHANISM FOR EJECTION OF WATER PRODUCED BY MELTING OF ICE IN SITU IN THE MIDDLE OF AN ICE CAP, OTHER THAN STEAM EXPLOSIONS.

WOULD NOT THE WATER SO PRODUCED FLOAT THE ICECAP, OR PORTIONS OF IT? IF A PAIL OF WATER BE FROZEN SOLID, THEN MELTED FROM BELOW, AS SOON AS THE ICE IS FREE FROM THE SIDES OF THE VESSEL IT WILL FLOAT, EVEN THO THERE BE ONLY A FILM OF WATER SURROUNDING IT. BY THIS VIEW, ALL THE WATER WOULD STAY AT THE BOTTOM AND THE ICE AFFECTED WOULD BE LIFTED OFF THE ICE-BURIED MTS.

BEAVERDELL TO COOKSON AUGUST 1 1926

PERHAPS THE GREAT FIND OF THE SEARCH FOR THE CAUSE OF THE SPOKANE FLOOD HAS BEEN MADE TODAY! A PART OF A VALLEY FLOW OF BASALT HAS BEEN LOCATED IN KETTLE RIVER VALLEY AT COOKSON. CORROBORATIVE EVIDENCE OF STRIKING CHARACTER ALSO EXISTS IN THIS VALLEY BETWEEN LOIS AND COOKSON.

BEAVERDELL REGION OF KETTLE RIVER VALLEY SHOWS LITTLE THAT CAN BE ASCRIBED DEFINITELY TO GLACIAL EROSION. THERE IS AN INTERRUPTED PROFILE TO THE SLOPES AND THE SPURS BUT THE ANGULAR ANGLE IN IT LIES SO FAR UP THE SLOPES THAT IT SEEMS BETTER TO INTERPRET IT AS THE UPPER VALLEY WALL LIMIT IN THE TRENCHING OF THE PRESENT DRAINAGE SYSTEM INTO THE ROLLING SURFACE OF THE OLD PENEPLAIN. A FEW LONE MOUNTAINS, STANDING ABOVE THE GENERAL EVEN SUMMIT LEVEL, SEEM TO BE MONADNOCKS OF THE PENEPLAIN CYCLE.

IF THE INTERRUPTED PROFILE IS NOT DUE TO GLACIAL EROSION, THEN THERE IS ALMOST NO EVIDENCE FOR CHANGES IN VALLEY PROPORTIONS HERE. SPURS OVERLAP IN THE VIEW DOWN THE VALLEY FROM CARMI. A DENSE FOREST GROWTH ON ALL SLOPES SHOWS THAT THERE IS AN ADEQUATE SOIL COVER; IN CONTRAST WITH THE SPARSE FOREST AND ABUNDANT BARE ROCK SLOPES AND LEDGES IN BRANBY RIVER VALLEY TO THE EAST. NO ROCK KNOBS, NO GOOD HANGING VALLEYS.

AND THERE IS POSITIVE EVIDENCE POINTING TO THE SAME CONCLUSION. THE MANY ROCK CUTS ALONG THE KETTLE VALLEY RR FROM THE WILKINSON CREEK LOOP NORTH TO COOKSON EXPOSE WEATHERED ROCK OVERLAIN BY FRESH GLACIAL TILL. BOTH ACIDIC AND BASIC IGNEOUS ROCK ~~ARE~~ INVOLVED AND BOTH WEATHERED. A DIKE OF GREENSTONE IN ONE CUT IS DECOMPOSED TO AN INCOHERENT MASS TO A DEPTH OF 10 FEET AND ONLY THE CORES OF THE JOINT BLOCKS BELOW THAT DEPTH TO THE BOTTOM OF THE CUT (15 FT.) SHOW THE GREENISH BLACK COLOR OF THE ORIGINAL ROCK. IT IS PERFECTLY CLEAR THAT GLACIAL EROSION HAS NOT OCCURRED ON THESE VALLEY SLOPES DURING WISCONSIN TIMES, NOR PROBABLY DURING SPOKANE TIMES, IF EVER AT ALL.

NOW, WITH THIS ESTABLISHED, IT IS OF GREAT INTEREST TO NOTE THAT THE KETTLE VALLEY ABOVE LOIS STATION CONTAINS MAGNIFICENT SIDE-HILL GASHES OF TREMENDOUS SIZE. IT SEEMS CLEAR THAT WHATEVER MADE THESE SIDEHILL GASHES WAS NOT GLACIAL EROSION.

THE KETTLE VALLEY RR MAKES A LONG LOOP BACK UP WILKINSON CREEK IN ORDER TO PASS THRU THE ARLINGTON LAKES VALLEY AT LAKEVALE STATION. THE LAKES VALLEY IS PARALLEL WITH THE KETTLE RIVER VALLEY, IS ABOUT 6 MILES LONG AND OPENS INTO THE KETTLE VALLEY AT BOTH ENDS. ITS FLOOR IS TWO OR THREE HUNDRED FEET ABOVE THE FLOOR OF KETTLE VALLEY AND THE RIDGE OF ROCK WHICH SEPARATES THE TWO IS 100 OR 200 FEET HIGHER THAN THE LAKES VALLEY. MOREOVER, THE LAKES VALLEY IS VERY NARROW AND HAS STEEP SLOPES WITH RATHER PROMINENT ROCK LEDGES, WHILE KETTLE VALLEY SLOPES ARE GENTLER AND ARE SOIL-COVERED ALMOST EVERYWHERE.

IN OTHER WORDS, ARLINGTON LAKES VALLEY IS A SIDE-HILL GASH. IT ALSO HAS MINOR LATERAL RIDGES AND GASHES ON ITS SLOPES, PLENTY OF THEM. THE COMMON OCCURRENCE OF ROCK EXPOSURES ON THE SIDES OF THE LAKES GASH AND ON THE SECONDARY RIDGES OF THOSE SIDES, AND THE FRESH-LOOKING BLOCKY TALUS SEEMS TO INDICATE MUCH LESS WEATHERING OF THE SIDE-HILL GASH SLOPES THAN OF THE PREGLACIAL SLOPES OF KETTLE RIVER VALLEY. THIS POINT, HOWEVER, WAS NOT FULLY APPRECIATED WHEN IN THE

*Beaverdell map  
400 ft.  
(500 ft. max)*

FIELD TODAY AND MUST BE RE-EXAMINED.

THERE ARE MANY SMALLER GASHES AND RIDGES IN THE FORESTED SLOPES OF KETTLE VALLEY HERE. ONE WAS NOTED BY REINECKE WHO ALSO MENTIONS "SMALL DRY DRAWS" ON THE HILLSIDES OF HALL CREEK VALLEY THAT "LOOK AS THO THEY HAD BEEN PARTLY SLICED OUT OF THE HILLSIDE". HALL CREEK IS ANOTHER NAME FOR ARLING CREEK, THE OUTLET OF ARLINGTON LAKES. SINCE THE LAKES LIE AT THE NORTH END OF THEIR VALLEY, THE STREAM DRAINS SOUTHWARD THRUOUT MOST OF THE LENGTH OF THE VALLEY.

THE ARLINGTON LAKES GASH WAS NOT APPRECIATED BY REINECKE AS A GIANT EXAMPLE OF A DRAW WHICH LOOKS AS IF IT HAD BEEN PARTLY SLICED OUT OF THE ~~HILLSIDE~~ MOUNTAIN SIDE. BUT IT CLEARLY IS. ONE WALKS NORTH FROM THE LAKES ALONG THE RR, A FEW TENS OF FEET ABOVE THEIR SURFACE, AND FINDS THE VALLEY ABRUPTLY OPENING OUT AT FULL WIDTH INTO THE KETTLE, THE FLOOR OF WHICH IS <sup>(400 by map)</sup> 200 FT AT LEAST BELOW. SUCH A VALLEY IS NO PRODUCT OF ANY TRIBUTARY STREAM AND SURELY NOT OF GLACIAL ~~EROSION~~ EROSION WHEN THE EVIDENCE OF THE ROCK CUTS IN WEATHERED MATERIAL FOR THE NEXT SIX MILES TO COOKSON IS CONSIDERED. IT MUST BE THE PRODUCT OF A GREAT STREAM FLOWING WHEN GLACIAL ICE WAS PRESENT.

ARLINGTON LAKES VALLEY IS NOT APPARENT AS A SIDE HILL GASH, BECAUSE OF ITS SIZE AND THE FACT THAT THE OBSERVER TRAVELS IN IT, ALONG THE RR WHICH IS THE ONLY ROUTE THRU HERE. PERHAPS IF IT COULD BE VIEWED FROM THE EAST SIDE OF THE KETTLE VALLEY, ITS CHARACTER WOULD BE MORE APPARENT. SUCH A GASH ON THE EAST SIDE SHOULD BE CLEARLY INTERPRETABLE FROM THE WEST SIDE.

NOW, SUCH A GASH DOES EXIST!! IT IS TRULY SPECTACULAR, ALSO. IT EXTENDS FOR ABOUT FOUR MILES ALONG THE EAST WALL, COOKSON BEING OPPOSITE ITS NORTHERN PART. ITS ORIENTATION IS SUCH THAT IT MIGHT BE CONSIDERED AS A NORTHWARD EXTENSION OF THE LAKES GASH, CROSSING THE RIVER IN THE AIR BETWEEN ITS SOUTHERN END AND THE LAKE GASHES NORTHERN END,

THIS EAST WALL SIDE-HILL-GASH OCCUPIES FULLY A THIRD OF THE WHOLE PREGLACIAL SLOPE FROM MT SUMMIT TO VALLEY BOTTOM, PERHAPS A HALF. PHOTO PERHAPS WILL SHOW PROPORTIONS.

LA VILLE FERGATI OT ERADNO 2ME38 TI TAHT ENAJ HADDANI OT 17246 YELJAY GINT DUJLA JIA JOMMOO DO  
ODRAS BHT RD SUJQH BHT HI QMARTS 1811 TAHD 3PA 420 .QMAERTS JAIQAJIS 1811 QMOROOG 2A  
DRAJHOOG RD PTHM 3PA BHT UNLI QMERTS .QMAERTS GINTRO TOR YJERUS ERA 3PA YELJAY KADCHAU  
BHT HANT QMOROOG 3PA YENT .QMAERTS 1811-2012 TAHD 3PA HOGJ ,ENAJ 3PA RD TAZM AND BHT QM  
3PA BOOGOOG OT 1811 3PA 3PA BHT RD QMOROOG BHT RD QMOROOG BHT RD QMOROOG

~~TRAIL BY ENAJ LOG~~  
~~Kettle Valley~~  
IT IS SEVERAL HUNDRED FEET DEEP ON ITS EASTERN WALL AND PROBABLY ALL OF 200 FEET DEEP ON ITS DOWN-HILL SIDE. IT CROSSES THREE PREGLACIAL RAVINED GROOVES WHICH DESCENDED TO THE KETTLE, SO THAT THE SEPARATING RIDGE BETWEEN IT AND THE KETTLE HAS AN UNDULATORY CREST, THE LOW PLACES BEING THE TRUNCATED GROOVES. A SHORTER SECONDARY RIDGE CAN BE SEEN ON THE EASTERN WALL. ALL WALLS ARE CLIFFED AND MUCH TALUS HAS ACCUMULATED IN THE GASH. NO OTHER SLOPES ON THIS VALLEY SIDE ARE CLIFFED.

THIS TRULY SPECTACULAR LAND FORM IS NOT ALONE ON THE EAST WALL OPPOSITE COOKSON. THERE IS ANOTHER SHARPLY MARKED INCISION ACROSS A SPUR JUST WEST OF THE HEAD OF THIS EASTERN GASH. IT LOOKS TO BE NEARLY A MILE WIDE AT THE TOP AND ITS SLOPES ARE VERY STEEP. IT IS A NOTCH RATHER THAN A LATERAL GASH, BUT IT CLEARLY BELONGS TO THE SAME CATEGORY.

HERE COMES NOW THE STATEMENT OF THE GREAT FIND (PERHAPS). IN THE BOTTOM OF KETTLE VALLEY AT COOKSON IS A VALLEY BASALT FLOW!! IT IS ABOUT 150 FEET BELOW THE RR AND THE STREAM HAS TRENCHED PERHAPS 75 FEET INTO IT. ITS SURFACE APPEARS LEVEL, ITS CLIFFS SHOW COLUMNAR STRUCTURE AND THE GREAT TALUS ACCUMULATION SEEMS ATTRIBUTABLE TO FRACTURING OF THESE COLUMNS. THE COUNTRY ROCK HERE IS METAMORPHOSED GRANITE, CHIEFLY, WITH SHEETING, SHEARING AND A FEW META-INTRUSIONS. THIS HORIZONTAL SHEET OF BASALT DOES NOT BELONG IN THE COUNTRY ROCK SERIES, OUTCROPPING HERE BECAUSE OF STREAM EROSION. THE BASALT IS VESICULAR OR SCORIACEOUS, CAVITIES UNFILLED, COLUMNS VERTICAL. IT IS CONFIDENTLY ACCEPTED AS THE SOUTHERN TONGUE OF THE PLEISTOCENE BASALT FLOWS WHICH ARE ANTICIPATED IN THE HIGHLAND TO THE NORTH, BETWEEN HEADWATERS OF THE VARIOUS KETTLE FORKS VALLEYS ~~WADSWORTH~~ AND THE VALLEY WHICH DRAINS WESTWARD TO THE OKANOGAN VALLEY AT VERNON. THERE WAS TOO LITTLE TIME TO EXAMINE THIS FLOW AND DETERMINE ITS EXTENT. IT QUITE SURELY DOES NOT REACH MORE THAN A MILE OR TWO SOUTH OF COOKSON. ITS NORTHWARD EXTENT IS STILL TO BE TRACED. WHAT FUN!

BEAVERDELL TO KELOWNA AUG 2 1926

REVIEW OF FEATURES OF WEST FORK KETTLE VALLEY ABOUT AND BELOW WESTBRIDGE SHOWS PLENTY OF STEEP CLIFFS WHICH SEEM TO BE THE PRODUCTS OF GLACIAL DEEPENING OR WIDENING. EVIDENCE FOR ACTUAL DEEPENING IS NOT GOOD, HOWEVER. AND THE VICINITY OF ROCK CREEK CARRIES LARGE DRIFT DEPOSITS ON THE MT. ELANX AND ONLY THE SHOULDER AND KNOBS ARE NOTICEABLY GLACIATED. VALLEYS OF ROCK CREEK AND BAKER (?) CREEK ALONG HIGHWAY WEST TO OSOYOOS, CARRY MUCH DRIFT IN TERRACES AND MORAINIC PILES ON THE NORTH WALLS. STREAMS ARE BOTH CLOSER TO SOUTH WALL AS THO THE ORIGINAL DEPOSIT WAS LARGEMLY MADE ON THE NORTH SIDE.

ROAD DOWN TO OSOYOOS LAKE PASSES THRU OR CLOSE BY A NUMBER OF SIDE-HILL GASHES OR NOTCHES THAT ARE VERY MARKED. BUT THEY ARE SO NUMEROUS AND SHARP PEGMS ON MT. SLOPES OR SHOULDERS ARE SO COMMON ALL ALONG THIS VALLEY NORTH TO OKANOGAN LAKE THAT IT SEEMS UNSAFE TO INTERPRET THEM ALL AS PRODUCED BY SUBGLACIAL STREAMS. SOME ARE GREAT MTS. STANDING IN THE MIDDLE OF THE BROAD OKANOGAN VALLEY AND ARE SURELY NOT OF THIS GENESIS. OTHERS, LIKE THE ONE NORTH OF PEACHLAND AND THE ONE WEST OF DOG LAKE, LOOK LIKE GREAT SIDE-HILL GASHES. THEY ARE MUCH LONGER THAN THE NOTCHES BACK OF THE PINNACLES ON THE SLOPE DOWN TO OSOYOOS LAKE.

MORAINE BETWEEN VASEAUX LAKE AND DOG LAKE IS 300 FT ABOVE VASEAUX. DOG LAKE IS 140 FT ABOVE VASEAUX LAKE. THE RIVER HAS CUT DOWN THRU THE MORAINE TO THE ROCK SHOULDER OR BARRIER AT OKANOGAN FALLS. THE WIDTH OF THE MORAINE IS THE DISTANCE BETWEEN THE TWO LAKES. THIS MORAINE MARKS A PAUSE IN THE RETREAT JUST BEFORE THE EPISODE OF DEPOSITION OF THE SILTS MARGINING DOG AND OKANOGAN LAKES.

KELOWNA TO MCCULLOCH AUGUST 3 1926

THE CHIEF SILT TERRACE EAST OF KELOWNA IS 300 FT ABOVE THE LAKE, OR 1430 A.T. AND IT IS AS THICK AS IT IS HIGH FOR SILT IS WELL EXPOSED FROM BOTTOM TO TOP. IF SILT WERE DEPOSITED AS DAWSON AND PARDEE ARGUE, THE BIG MORAINE BETWEEN VASEAUX AND DOG LAKES WOULD HAVE BEEN SUBMERGED AND WOULD CARRY SILT. THERE ISN'T A SUGGESTION OF SILT TERRACES ON THIS MORAINE, NOR OF ANYTHING BUT THE MEREST BEGINNING OF EROSION ON IT. THE MORAINE WHERE CROSSSED BY THE HIWAY IS 160 FEET ABOVE DOG LAKE OR 1276 A.T. THIS MORAINE THEREFORE WAS NOT THE DAM FOR THE LOCAL

LAKE OR LAKES IN WHICH THE EXTENSIVE SILTS OF OKANOGAN LAKE WERE DEPOSITED. THERE IS THEREFORE NO OTHER INTERPRETATION THAN THAT OF NARROW MARGINAL WATER BODIES, NOT ALL OF WHICH COULD HAVE BEEN CONNECTED, LYING BETWEEN A SHRINKING ICE TONGUE AND THE VALLEY WALLS. IT IS A PUZZLE WHY THESE LAKES, SO CLOSE TO ICE AND TO ROCK, SHOULD HAVE SUCH WELL-SORTED SILT, WITHOUT SAND OR GRAVEL OR STRAY COBBLES AND BLDRS THRU MANY FEET OF THICKNESS. THE TILL IN THIS VALLEY (AND ELSEWHERE IN THE PART OF B.C. STUDIED) IS VERY LIGHT COLORED AND HAS A CONSIDERABLE AMOUNT OF SILTY TEXTURED MATERIAL. SLACKWATER LAKES MUST HAVE BEEN FILLED RAPIDLY WITH THIS. COUNT THE VARVES AND SEE IF "RAPIDLY" IS CORRECT.

OTHER TERRACES OF SILT OCCUR UP MISSION CREEK ALONG THE ROAD TO MCCULLOCH. A VERY PROMINENT TERRACE OF SILT, WITHOUT GRAVEL ON TOP, LIES AT 2200 (2300?). IT IS 200 FT THICK. THE UPPER PART IS CLEAR SILT, THE LOWER PART HAS PEBBLES AND COBBLES, SOME OF THEM STRIATED, SO ABUNDANTLY DISTRIBUTED THAT THE DEPOSIT LOOKS MUCH LIKE TILL. IT STRATIFICATION HOWEVER IDENTIFIES IT AS SILT. ITS ALTITUDE IS WAY ABOVE PARDEE'S UPPER LIMIT FOR THE NESPELEM FORMATION AND NOTHING BY ICE COULD HAVE HELD IT BACK IN THIS VALLEY DURING DEPOSITION.

FURTHERMORE, THERE IS A PROMINENT WIDE TERRACE OF GRAVEL EAST OF KELOWNA AT 500 FT+ ABOVE THE LAKE. IN ONE PIT ALONG THE ROAD, VERY FINE FORESET BEDS ARE EXPOSED, DIPPING TOWARD THE LAKE. THE MAIN SILT TERRACE IS BELOW (IN ALTITUDE) AND THE MISSION CREEK SILT TERRACE IS ABOVE (HIGHER) AND FOUR OR FIVE MILES FARTHER AWAY FROM THE LAKE. THESE FACTS CANNOT BE HARMONIZED BY THE GENERAL SUBMERGENCE HYPOTHESIS OF DAWSON AND PARDEE.

IN THE VICINITY OF MCCULLOCH IS AN EXTENSIVE BASALT PLATEAU-LIKE UPLAND, WHOSE ALTITUDE IS 4000 TO 4200. IT IS THE LONG SOUGHT LAVA FLOW, THE CAUSE OF THE SPOKANE FLOOD! PERHAPS!!

THE BASALT IS EXPOSED IN THREE RAILROAD CUTS SOUTH OF MCCULLOCH FROM ONE TO TWO MILES. IT IS VERY RUDELY COLUMNAR WITH HUGE JOINT-DETERMINED FRAGMENTS. ITS COLOR IS BLUE BLACK TO PINKISH BLACK. ITS VESICULARITY IS IN HORIZONTAL BANDS OR ZONES OF BUBBLES AND ALSO IN VERTICAL STRINGS OR PIPES OF BUBBLES. THESE ARE VERY YOUNG MARKED IN SOME PLACES. SOME OF THE HORIZONTAL SEAMS OF BUBBLES ARE VERY NARROW, HARDLY TWO INCHES IN WIDTH. SOMEWHAT UNDULATORY BUT REMARKABLY CONTINUOUS. I HAVE NEVER BEFORE SEEN ANYTHING QUITE LIKE THEM.

IS THE PLATEAU, TRAVERSED BY THE ROAD TO MCCULLOCH FOR PERHAPS THREE MILES. ABOUT THE STATION, IT IS FAIRLY WELL SHOWN BY REASON OF THE RAILROAD CLEARING, A RANCH CLEARING AND THE KELOWNA IRRIGATION RESERVOIR CLEARINGS. THE SURFACE OF THE PLATEAU IS UNDULATORY, SOME OF THE RELIEF DUE TO EROSION, SOME PERHAPS TO ORIGINAL PROFILES OF THE FLOWS. IN PARTICULAR, THREE SYMMETRICAL, LOW CONICAL HILLS EAST OF THE STATION APPEAR LIKE THE LAVA CONES OF THE SNAKE RIVER LAVA PLAINS AND NOT LIKE THE SUMMITS OF PARTIALLY SUBMERGED MTS. (STEPTOES). BUT THE COUNTRY IS SO DENSELY FORESTED THAT AGOOD IDEA OF THE CHARACTER OF THE PLATEAU HERE IS DIFFICULT TO OBTAIN.

THE POOR DRAINAGE OF THE PLATEAU AT THE SUMMIT IS NOT WORTHY. THE IRRIGATION RESERVOIR DISCHARGES NORTHWARD TO HYDRAULIC OR CANNON CREEK BUT THE OVERFLOW DISCHARGES TO KETTLE RIVER. AT LEAST THREE DAMS HAVE BEEN CONSTRUCTED TO HOLD THIS WATER IN. A LAKE ALSO LIES HERE, A LITTLE HIGHER PERHAPS THAN THE RESERVOIR. OTHER LAKES IN THE VICINITY ARE SHOWN ON THE MAPS.

THE PLATEAU HAS BEEN GLACIATED. FRESH WISCONSIN TILL IS 30 FEET THICK OR MORE AT THE NORTH END OF THE RESERVOIR. EAST OF THE LAKE ALONG THE RAILROAD, THE SURFACE OF THE BASALT IS BARE AND CARRIES WEATHERED GLACIAL GROOVINGS WHICH STRIKE ABOUT S 20°E. THERE ARE NO NEARBY ELEVATIONS TO INFLUENCE THE COURSE OF THE ICE HERE. TILL TO LEE (S) OF THESE HIGHER SURFACES

OF BASALT IS FULL OF HUGE BOULDERS OF BASALT, AS MUCH AS 8 FT. IN MAX. DIAMETER, AND STRIKINGLY STRIATED THO THEY HAVE BEEN CARRIED ONLY A FEW HUNDRED FEET FROM THEIR SOURCE.

BASE OF THE BASALT NOT FOUND. IT MUST BE FOUND AND ITS RELATIONS TO UNDERLYING SURFACES DETERMINED IF IT IS TO BE ESTABLISHED AS PLEISTOCENE IN AGE.

A HILL OF REMARKABLY THIN, REMARKABLY REGULAR LAVA FLOWS, WITH UNIFORM COLUMNS FROM BOTTOM TO TOP, ALONG NORTH SIDE OF MISSION CREEK ABOUT HALF WAY BETWEEN MCCULLOCH AND KELOWNA. IT IS MUCH LOWER THAN THIS PLATEAU BASALT, AND DOUBTLESS THE HILL ~~WHICH THEY CONSTITUTE~~ IS PREGLACIAL IN ORIGIN. NOT YET TO BE CONSIDERED AS THE SAME BASALT. FLOWS CONSIDERABLY WARPED OR BENT IN PLACES.

WHY SHOULD THIS PLATEAU BASALT CEASE SO ABRUPTLY TOWARD THE DEEP ~~CANYON~~ OKANOGAN VALLEY? IT IS HALF A MILE ABOVE THE LAKE AND THE DESCENT THENCE IS FAR STEEPER THAN THAT DOWN THE KETTLE TO THE SOUTH. THE YOUTHFULNESS OF THE PLATEAU IS SO MARKED THAT IT SEEMS IMPOSSIBLE TO ASCRIBE THE DEVELOPMENT OF THE WIDE OKANOGAN VALLEY WITH ITS GROUPS OF ISOLATED HILLS AND SINGLE ISOLATED HILLS TO POST-BASALT TIME. JUST AS IT SEEMS IMPOSSIBLE TO CONSIDER THE KETTLE VALLEY TO THE SOUTH AS YOUNGER THAN THE BASALT.

FROM KELOWNA UP MISSION CREEK AUGUST 4 1926 (CONT'D) RELATED BY ROBERT TIEPKE

PURPLE MT AT THE HEAD OF JOE RICH CREEK WAS CLIMBED TO ABOUT 4700 NO BASALT IN IT— NO BASALT IN SIGHT— NO PLATEAU IN SIGHT. MT. PTARMIGAN (BIG WHITE MT) EAST OF COOKSON AND WEST OF DAMFINO CREEK RISES AT LEAST 2000 FT ABOVE PURPLE MT'S SOUTHERN PROMONTORY AND APPEARS HEAVILY GLACIATED, FOR RUBBED ROCK LEDGES ARE PLAINLY VISIBLE AND THE SUMMIT AND SLOPES ARE ROUNDED. MT. PTARMIGAN APPEARS TO BE A MONADNOCK ON THE INTERIOR PLATEAU PENEPLAIN. SUMMIT OF PURPLE MT, AT THE SOUTH END AT LEAST, IS VERY GREATLY ABRADED BY ICE, VERY LARGE GROOVES AND RIDGES RECORDING THE EROSION. GROOVES ARE 20-30 FEET DEEP. SCATTERED ERRATIC MATERIAL ON TOP.

WHERE IS THE BASALT PLATEAU WHICH IS NECESSARY FOR THE SUBGLACIAL VULCANISM HYPOTHESIS? IF IT EXISTS, IT CAN ONLY BE TO THE EAST OF PURPLE MT. AND IN THE HEADWATERS OF KETTLE AND DAMFINO STREAMS. THIS IS AN ALMOST INACCESSIBLE COUNTRY! IT SHOULD BE APPROACHED, APPARENTLY, FROM THE VERNON-EDGEWOOD ROAD, BY WAY OF DAWSON'S BASALT ON THE SHUSWAP SHEET.

AS SEEN FROM THE TOP OF PURPLE MT., THE WHOLE REGION IS A DISSECTED RUGGED PLATEAU TRACT, WITH ONLY PTARMIGAN AS REAL MOUNTAINOUS TOPOGRAPHY AND ALTITUDE. INDIAN GUIDE SAYS SNOW LINGERS THERE ALL THE SUMMER. THERE IS NO SIGN FROM TOP OF PURPLE OF THE GREAT OKANOGAN VALLEY ABOUT KELOWNA. BLACK KNIGHT MTN., WHICH STANDS UP SO STRIKINGLY ABOVE THE VALLEY, IS ONLY THE WESTERN MARGIN OF THE DISSECTED PLATEAU. WHAT IS THE ORIGIN OF THIS WIDE VALLEY? IT APPARENTLY HAS A NUMBER OF LOWER ERODED HILLS IN IT, AS THO IT WERE AN OLD LOWLAND OF THE PREGLACIAL STREAM SYSTEM. YET IT MAY BE STRUCTURAL FOR IT IS FAR WIDER THAN THE VASEAUX LAKE PART OF THE VALLEY. YET AGAIN VASEAUX MAY MARK THE PREGLACIAL DIVIDE REGION, THE <sup>Canadian</sup> OKANOGAN THEN DRAINING NORTHWARD. MORAINIC TOPOGRAPHY ON THE SOUTH SLOPE OF BLACK KNIGHT MTN IS STRIKINGLY DEVELOPED. I HAVE NEVER SEEN MORE SHARPLY ACCENTED HILLS OF TILL. THEY ARE VERY IRREGULAR, VERY STEEP-SIDED. INDIVIDUAL HILLS ARE 50 TO 75 FEET HIGH. UNDRAINED DEPRESSIONS ARE COMMON. THEY RANGE ALONG THE MT. SLOPE THRU NEARLY 1000 FT OF ALTITUDE.

THE GREAT SIDE-HILL CANYON SEEN EAST OF COOKSON OPENS OUT TO THE NORTH THRU A LONG WESTERN SPUR OF PTARMIGAN MTN. IT IS REPORTED TO BE WITHOUT A STREAM THO WHERE THE LONG NORTHEASTERN TRIB TO WEST FORK OF KETTLE GOES IN THAT CASE IS A PUZZLE. PERHAPS THE GASH SEEN TO THE SOUTH

FROM PURPLE MTN. ISN'T THE REMARKABLE SIDEHILL GASH BUT IS THE EQUIALLY DEEP NOTCH JUST WEST OF THE LONG GASH.

AT ANY RATE, THE CANYON SEEN FROM PURPLE MTN IS OUT OF HARMONY WITH ALL THE REST OF THE TOPOGRAPHY. THE COUNTRY NORTH OF PTARMIGAN SEEMS TO BE WITHOUT SHARPLY CUT VALLEYS, YET THE DRAINAGE GOES SOUTHWARD, EITHER THRU THE GASH OR THE NOTCH. FURTHER, THIS COUNTRY NORTH OF PTARMIGAN IS LARGELY LOWER THAN THE SPUR THRU WHICH THE GASH AND NOTCH ARE CUT. IT IS ALL VERY CURIOUS.

BASALT REPORTED AT MYRA IN RR CUT, THIS MUST BE SEEN, WHAT ARE ITS RELATIONS TO THE BASALT FLOWS AT MCCULLOCH? WARDWELL OR WARDLOW, THE RANCHER AT MCCULLOCH SAYS MUCH OF THE COUNTRY WEST OF MCCULLOCH IS ~~NOT~~ LIKE THAT ABOUT THE STATION— WITHOUT GREAT RELIEF— A PART, PRESUMABLY, OF THE LAVA PLATEAU. BUT THIS DISTRICT IS TOO SMALL TO HAVE FUNCTIONED AS A CAUSE FOR THE SPOKANE FLOOD. THERE MUST BE MORE TO THE EAST AND THE NORTHEAST, OR THE GASH AND THE NOTCH EAST OF COOKSON AND THE ARLINGTON LAKES VALLEY ARE WITHOUT SUPPORT AS PRODUCTS OF SUBGLACIAL VULCANISM. AND IF THEY ARE NOT, THEN NO GASHES OR NOTCHES CAN BE OF THIS GENESIS.

VERNON TO CHERRYVILLE AUG. 6 1926

THE THRU VALLEY BETWEEN THE OKANOGAN AND SHUSWAP VALLEYS IS BETWEEN 1700 AND 1800. ALT. OF SURFACE OF LONG LAKE (WOOD LAKE) IS 1293 AND ALTITUDE OF SHUSWAP RIVER AT JCT OF BESETTE CR. IS 1500. THE DIVIDE IS 8 MILES FROM LONG LAKE AND ABOUT 12 FROM THE SHUSWAP. THE THRU VALLEY SEEKS BUT LITTLE MODIFIED FROM PREGLACIAL PROPORTIONS EXCEPT NEARLY THE WEST END WHERE THERE ARE SEVERAL ROCK HILLS IN IT, THE LARGEST OF WHICH IS 1000 FT ABOVE LONG LAKE. ONE OF THESE HILLS LIES SO CLOSE TO THE SOUTH WALL AND IS SO ELONGATED PARALLEL TO THE MT WALL THAT IT SHOULD BE CLASSIFIED AS A SIDE HILL GASH. TWO SMALL LAKES IN IT ALSO.

THESE ROCK KNOBS AND HILLS APPEAR TO BE OF THE SAME GENESIS AS THOSE IN THE GLACIALLY DEEPENED VALLEYS ALREADY EXAMINED. IF THIS BE THE CASE, THE ~~LONG~~ LONG LAKE AND OKANOGAN LAKE BASINS HAVE BEEN GLACIALLY ERODED INTO THE BEDROCK BELOW PREGLACIAL PROFILES. COLDSTREAM VALLEY AND THE BESETTE CREEK VALLEY HAVE TRUNCATED SPURS AND FAIRLY WELL ALIGNED SIDES BUT NO HANGING VALLEYS WERE OBSERVED.

THE CREIGHTON VALLEY—ECHO LAKE VALLEY, SOUTH OF CAMELS HUMP AND ITS ASSOCIATED HILLS, TO THE EAST, IS A REMARKABLY NARROW, DEEP, STEEP-WALLED CANYON WHICH IS NOW PARTLY BLOCKED BY DRIFT TO FORM THE LAKE BASINS. ITS CLOSE PARALLELISM WITH THE VALLEY NORTH OF CAMELS HUMP RANGE OF HILLS IS CURIOUS, AND ITS NARROWNESS AND LOW GRADIENT ARE OUT OF HARMONY WITH THE OTHER LOW GRADIENT VALLEYS OF THE REGION. IT IS MORE LIKELY THE VALLEYS OF HARRY CREEK, DUTEAU CREEK, ETC., WHICH DESCEND AS MUCH AS 3000 FEET IN THE DISTANCE THAT CREIGHTON CREEK DESCENDS LESS THAN 1000 FEET.

AS UNUSUAL AS CREIGHTON CREEK VALLEY IS THE CAMELS HUMP RIDGE WHICH BLOCKS IT OFF FROM THE SHUSWAP. CAMELS HUMP IS A STARTLINGLY STEEP-WALLED MONOLITH, WHICH STICKS UP MOST CONSPICUOUSLY ABOVE ITS SURROUNDINGS. IT SUGGESTS DEVILS TOWER, AS SEEN FROM THE WEST. IT IS COMPOSED OF A LAVA WHICH IS, OR WHICH WEATHERS, ALMOST WHITE. COLUMNAR STRUCTURE IS PRESENT, THO POORLY DEVELOPED. THE TOPOGRAPHY SHOWS STEEP SLOPES AND CONSIDERABLE CLIFFING EVERYWHERE IN THE AREAS WHICH DAWSON MAPS AS MIocene BASALT. WHATEVER THE CORRECTNESS OR INCORRECTNESS OF DAWSON'S DETERMINATION OF THIS LAVA AS BASALT, IT CERTAINLY IS A GEOLOGICALLY LATE EFFUSION, BUT IT ALSO HAS BEEN GREATLY ERODED FOR CREIGHTON CREEK VALLEY CUTS IT AND THE EMPTY VALLEY CONNECTING BESETTE CREEK AND SHUSWAP RIVER CROSSES IT. GLACIAL EROSION WAS SEVERE IN THE SHUSWAP NORTH—

EAST OF CAMELS HUMP THO WHICH WAY THE ICE MOVED ISN'T CLEAR. CAMELS HUMP DOUBTLESS WAS SEVERELY SCRUBBED AND PROBABLY PLUCHEON THE WEST SIDE.

VICINITY OF ABERDEEN LAKE AUG. 7 1926

THE UPLAND SOUTH OF COLDSTREAM-BESSETTE VALLEY, AND EAST OF OKANOGAN VALLEY IS AN UNDULATING PLATEAU ABOVE 4000 AND WITH BUT LITTLE OF IT EXCEPT THE BROAD BUCK HILLS ~~KNOB~~ DOME ABOVE 5000. ONLY A FEW VALLEYS ARE TRENCHED INTO IT AND THESE ARE PREVAILINGLY YOUTHFUL. MANY LAKES ON IT AND MANY HILLS THAT ARE ROUGHLY CIRCULAR IN OUTLINE. ONE OF THESE HILLS WAS CLIMBED. IT IS JUST WEST OF THE ROAD TO ABERDEEN LAKE, IN THE LATITUDE OF THE NORTH END OF THE LAKE. IT IS A BASALT HILL ABOUT 400 FEET ABOVE THE HIGHEST SURROUNDING LAND. ITS SLOPES ARE VERY STEEP, IN PLACES CLIFFED, AND ARE COVERED WITH LARGE BLDRS OF BASALT, WITH HERE AND THERE AN ERRATIC COBBLE OR BLDR.

ITS SUMMIT IS 500-600 FEET ACROSS AND STRONGLY GLACIATED. THE HILL IS ABOUT A MILE ACROSS AT THE BASE. IT IS QUITE OUT OF HARMONY WITH THE SURROUNDING SLOPES. BLDRS AND COBBLES, BUT LITTLE WORN THO GLACIATED, ARE STREWN ALL ALONG THE ROAD ON THE EAST SIDE AND SOUTH TO THE SOUTH END OF ABERDEN LAKE. NORTH OF THE HILL, THE DRIFT IS TOTALLY LACKING IN BASALT.

THE BASALT IS DENSE AND VERY FINE-GRAINED, BLACK TO BLUE-BLACK WHERE UNWEATHERED, GRAY ON WEATHERED SURFACES. VERY LITTLE SCORIACEOUS TEXTURE SEEN.

YET WITH ALL THE LACK OF SCORIACEOUSNESS, THIS CONICAL HILL IS HERE INTERPRETED AS A LAVA CONE. IT STANDS ON A BASEMENT OF THE SHUSWAP GRANITE AND GNEISS WHICH IS EXPOSED IN LEDGES BOTH NORTH AND SOUTH OF THE BUTTE. THE LAKE BASIN WHICH IS BETWEEN 4200 AND 4300 IN ALTITUDE, IS IN THE SHUSWAP GNEISS. IF THIS HILL IS NOT A LOCAL CONE, IT MUST BE A REMNANT LEFT IN THE EROSION OF A COMPLETE ~~ONE~~ BASALT LAVA FLOW COVER OF THE PLATEAU. THIS ALTERNATIVE INTERPRETATION HAS MANY OBJECTIONS TO IT. ONE OF THE MOST SEVERE RESTRICTIONS IS THE QUERY WHY EXTENSIVE FLOWS OF SUCH TOPOGRAPHIC RECENCY SHOULD NOT HAVE RUN DOWN THE VALLEY SLOPES, EVEN IF POURRED OUT FROM VENTS IN THE UPLAND WHICH AVERAGES HALF A MILE ABOVE THE GREAT ADJACENT VALLEYS.

IS THE VOLCANIC FIELD FOR WHICH I AM LOOKING TO TURN OUT TO BE A PATCHY GROUP OF LITTLE CONES AND LITTLE FLOWS? IS IT ALL GOING TO BE ON UPLANDS WHERE THERE IS LITTLE CHANCE OF CANYONING TO SHOW THE BASE OF THE BASALT? IS IT GOING TO BE ON UPLANDS WHERE THE ICE WAS THIN AND CONSEQUENTLY THE AMOUNT OF WATER YIELDED BY THE SUBGLACIAL MELTING WAS AT A MINIMUM?

SILT UP CREIGHTON CREEK VALLEY IN CONSIDERABLE QUANTITY BUT NO TERRACE FORMS RECOGNIZED. ALSO IN STREAMLESS VALLEY BETWEEN BESSETTE CR. AND SHUSWAP RIVER.

VERNON TO KETTLE RIVER ON EDGEWOOD ROAD. AUG. 7 1926

THE PASS USED BY THE ROAD FROM MONASHEE CREEK TO KETTLE RIVER DRAINAGE IS A DEEP, STEEP-WALLED, NARROW VALLEY. LAKES AND SWAMPS AND MEADOWS AT THE PASS. HEAVY DRIFT UNIFORMLY SPREAD, LITTLE BEDROCK SHOWING AND NO DRIFT FORMS. RIGHT IN THE MIDDLE OF THIS VALLEY, A LITTLE SOUTH OF THE DIVIDE, STANDS A NARROW BLADE-LIKE ROCK HILL, PERHAPS 75 FEET HIGH AND WITH WATER STANDING OR FLOWING ON BOTH SIDES. IT IS A VERY PECULIAR FORM FOR GLACIAL EROSION TO PRODUCE AND IF IT WERE IN THE PROPER LOCATION, IT MIGHT WELL BE ASCRIBED TO SUBGLACIAL STREAM ACTION IN THE PASS. BUT THE LOCATION SEEMS TO BE WRONG IF THE VOLCANIC FIELD IS ON THE ABERDEEN/IDEAL UPLAND. IT IS POSSIBLE TO CONCEIVE, HOWEVER, OF WATER MOVING NORTHWARD FROM THE

AREA OF MELTING BENEATH THE ICE, BMOYING IT, BEING UNDER GREAT PRESSURE, AND ESCAPING SOUTHWARD TO THE KETTLE BY THIS ROUTE AS WELL AS GOING OUT BY WAY OF LONG LAKE AND OKANOGAN LAKE.

GRANITE OF THE MTS HERE BENEATH THE DRIFT IS PRETTY MUCH DECOMPOSED, THO NOT REDBEDDED. THE DRIFT IS FRESH WISCONSIN MATERIAL. THE SITUATION SEEMS PARALLELED BY THAT IN THE UPPER KETTLE WEST FORK BETWEEN LAKEVILLE AND COOKSON. SOUTH-DRAINING VALLEYS A SHORT DISTANCE SOUTH OF THEIR DIVIDES SEEM TO ESCAPE THE GLACIAL EROSION THAT IS IN EVIDENCE ELSEWHERE.

THE PASS AT THE HEAD OF MONASHEE CREEK IS 4000, WHICH IS 250 FEET ~~AS~~ LOWER THAN KETTLE RIVER WHERE CROSSED BY THE HIWAY, FARTHER SOUTH/NEAST, TEN MILES SOUTH OF ITS HEAD. DOES THIS BEAR ON THE PROBLEM OF THE ORIGIN OF THE BLADE-LIKE HILL IN THE PASS?

NO UNMETAMORPHOSED BASALT COBBLES FOUND IN THE GRAVELS OF KETTLE OR MONASHEE WHERE ACCESSIBLE FROM THE HIWAY. NOR IN DRIFT EXPOSED ROAD CUTS. NOR IN BEDROCK WHERE SHOWN ALONG THE ROUTE. AND THE TOPOGRAPHY HERE IS THAT OF VALLEYS AND RIDGES, NOT OF UPLAND FLATS LIKE ABERDEEN. NO SUGGESTION THEREFORE, IN THE TOPOGRAPHY, OF GEOLOGICALLY RECENT BLOWS. THE LOW RIDGE BETWEEN KETTLE RIVER AND THE TRIB OF KETTLE SOUTH FROM MONASHEE DIVIDE IS 360 FEET ABOVE THE KETTLE AND 600 ABOVE THE MONASHEE DIVIDE PASS. AND SLOPES ARE STEEP.

SILT DEPOSIT ~~NE~~ OPENED A MILE OUT OF VERNON ON LUMBY ROAD IS WELL STRATIFIED AND FROM THE ROAD THERE APPEARS TO BE A FAIRLY CONSTANT ALTERNATION LIKE THE SUCCESSION IN VARVES. BUT CLOSER EXAMINATION SHOWS THE SILT TO BE VERY SANDY IN PARTS AND TO HAVE PEBBLES SCATTERED THRU IT AT ALL HORIZONS. IT APPEARS TO HAVE BEEN DEPOSITED PRETTY NEAR <sup>TO</sup> MELTING ICE AND TO HAVE HAD FAIRLY VIGOROUS CURRENTS IN THE POND DURING ITS DEPOSITION.

#### VERNON TO TRINITY HILLS AND SALMON ARM SUNDAY AUGUST 8 1926

DAWSON'S GRANITIC BRECCIA ON TRINITY HILLS WAS FOUND REPRESENTED ABUNDANTLY IN THE DRIFT NEAR BOBBIE BURNS P.O. (TRINITY VALLEY). IT IS A THOROUGHLY INDURATED COARSE-GRAINED ARKOSE AND NOT TO BE ASCRIBED TO VOLCANIC ACTION OF ANY SORT. COMPLETE PEBBLES OF UNWEATHERED GRANITE FOUND IN THE DENSE, HARD, LIGHT-COLORED MATRIX.

LEDGES OF A FINE GRAINED BLACK ROCK, PRESUMABLY BASALT, SEEN ALONG THE ROAD ON WEST FLANK OF TRINITY HILLS. IT IS INCONSPICUOUSLY AND MINUTELY BUT MOST SURELY SCHISTOSE, AND THEREFORE NOT MIocene FOR IT ANTEDATES THE ORIGINAL MT-MAKING. FRAGMENTS OF A SCORIAEOUS BASALT, BROWN-ISH AND GRAYISH (ESPECIALLY), FOUND IN THE DRIFT WEST OF TRINITY MAY HAVE COME FROM THE TRINITY HILL GROUP BUT PROBABLY CAME FROM THE NORTH ALONG WITH OTHER ERRATICS.

THE TRINITY HILLS AND BOBBIE BURNS MT. ARE TOPOGRAPHICALLY OLD FORMS, WHITLED OUT LONG BEFORE GLACIATION. NOTHING HERE IN TOPOGRAPHY OR IN ROCK OR DRIFT TO SUGGEST PLEISTOCENE VULCANISM.

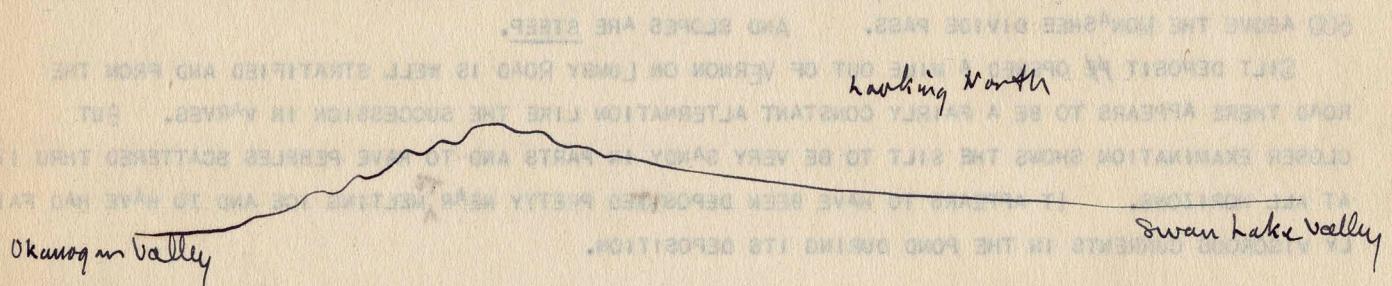
IS THERE ANY HOPE OF RECONSTRUCTING THE PREGLACIAL DRAINAGE PATTERN OF B.C.? THE ICESHEET WHICH OVERRODE VIRTUALLY EVERYTHING MUST HAVE CUT OUT MANY LOW PREGLACIAL DIVIDES, PERHAPS IN SOME CASES TO MAKE DEEP VALLEYS. THE CONSEQUENCE IS A PLEXUS OF ANASTOMOSING DEEP VALLEYS, WITH STREAMS PURSUING MOST ANOMALOUS COURSES FROM ONE VALLEY TO ANOTHER, AND WITH THE HIGHLANDS PRETTY WELL SEPARATED INTO ISOLATED GROUPS A FEW MILES IN DIAMETER. SOME ARE MUCH ELONGATED, AS THE RIDGE OF HILLS BETWEEN OKANOGAN LAKE AND DOG LAKE VALLEYS, OTHERS ARE CIRCULAR. NO KEY TO THE PUZZLE SEEMS IN SIGHT WITHOUT MOST CAREFUL DETAILED STUDY.

DRIFT DEPOSITS IN THE THRU VALLEY BETWEEN ENDERBY AND SALMON ARM ARE INSTRUCTIVE. THERE IS

MUCH TRULY MORAINIC TOPOGRAPHY ON THE SURFACE OF THE VALLEY FILL AND NOT MUCH IN SIGHT ON THE MT. SLOPES. THE HILLS ARE KAMES, RATHER THAN TILL ACCUMULATIONS. EVERY ROAD CUT SHOWS REMARKABLY DEVELOPED FORESET BEDDING, THE DIP VARYING CONSIDERABLY IN ANY ONE CUT. NO SYSTEM TO THE DIRECTION OF DIP WAS OBSERVED, BUT IT SEEMS CLEAR THAT ICE STOOD ADJACENT TO AND AS HIGH AS OR HIGHER THAN EACH KNOB WHEN IT WAS BUILT.

DRIFT DEPOSITS IN THE THRU VALLEY BETWEEN GLENEMA AND THE HEAD OF OKANOGAN LAKE ALSO TELL AN INTERESTING STORY. AS BETWEEN ENDERBY AND SALMON ARM, THE DRIFT IS MORAINIC IN EXPRESSION, GRAVELLY IN COMPOSITION, AND LOCATED ON THE VALLEY FLOOR. A LONG LINE OF SMALL LAKES LIES IN A LINEAR VALLEY THAT IS BORDERED ON THE EAST BY GOOD DRIFT TERRACES, AND IN PART ALSO ON THE WEST. THIS VALLEY IS NO STREAM-CUT AFAR; IT IS A CAST OF AN ICE TONGUE.

ANOTHER GOOD CASE IS THAT OF THE NORTH END OF OKANOGAN LAKE AND THE ADJACENT SWAN LAKE VALLEY. ICE STOOD IN THE OKANOGAN VALLEY WHILE A BIG MORaine WAS DEPOSITED ALONG THE EAST BANK AND OUTWASH MATERIAL WAS DEPOSITED EAST OF THIS. MUCH OF THE OUTWASH WAS SILT AND PROBABLY A LAKE, RATHER THAN STREAMS, WAS RESPONSIBLE FOR THE GENTLY SLOPING PLAIN EAST OF THE MORaine.



SWAN LAKE MAY BE CONSIDERED THE SURVIVOR OF THE PLEISTOCENE LAKE. DAWSON'S BASALT OF THE MT. IDA GROUP IS A PLATy GREY BASIC ROCK WITH SOME SCORIAEous PHASES, POORLY DEFINED FLOW SUCCESSION, AND ALMOST NO COLUMNAR STRUCTURE. ACCORDING TO DAWSON'S MAP, IT MUST BE POST-VALLEY IN AGE, AND THE EXAMINATION TODAY FROM THE VALLEY OF SALMON RIVER SUPPORTS THIS VIEW. THE MT. IDA SUMMIT SEEMS PROBABLY THE SHARPENED ERODED CONE FROM WHICH THE FLOWS CAME. BUT THEY MAKE NO DIFFERENCE WITH THE WIDTH OF THE VALLEY HERE AND IT SEEMS ALTOGETHER LIKELY THAT THEY DID NOT FLOW FAR DOWN INTO IT, AND HAVE BEEN CLEANED OUT SINCE OR ELSE THAT THE VALLEY THEY ORIGINALLY ENTERED HAPPENS TO COINCIDE WITH A PRESENT ONE. I.E. THE PREBASALT VALLEY HAS BEEN RE-EXCAVATED. THERE IS NO SUGGESTION OF THE MODIFICATION OF PRESENT TOPOGRAPHIC FEATURES, OTHER THAN THE DEVELOPMENT OF PROMINENT CLIFFS AND SUPPORT OF A VERY PROMINENT SUMMIT, WELL ABOVE EVERYTHING ELSE NEAR IT. IS IT PLEISTOCENE?

NO SIDE-HILL GASHES ANYWHERE NORTH OF VERNON IN TODAY'S TRAVERSE. BASALT WEST OF VERNON ON THE HILLS BETWEEN THE TOWN AND THE MAIN VALLEY OF OKANOGAN LAKE. WHAT AGE? WHAT TOPOGRAPHIC RELATIONS? NO REAL CLUE FOUND, THO THE BASALT SEEMS TO BE PRE-TOPOGRAPHY. IT WEATHERS GRAY, UNLIKE THE McCULLOCH AND ABERDEEN LAKE BASALTS.

#### VICINITY OF IDEAL LAKE AUGUST 10 1926

IDEAL LAKE LIES ON THE SOUTHERN EDGE OF THE PLATEAU ALREADY NOTED, AND ITS DRAINAGE SPILLS OVER INTO MISSION CREEK BY A STEEP GRADIENT. THE LAKE, NO<sup>N</sup> ENLARGED INTO THE B.M.I.D. RESERVOIR, REQUIRES THREE DAMS TO CLOSE THE BASIN. THE VALLEYS THUS CLOSED ARE IN THE SHUSWAP GNEISS EXCEPT THE WESTERN ONE WHICH HAS GNEISS ON THE EAST SIDE AND BOTTOM, AND BASALT ON THE

WEST SIDE. NO ACTUAL CONTACT FOUND.

THE BASALT IS COLUMNAR, THE COLUMNS SOMEWHAT IRREGULARLY DISPOSED AND TO A SMALL EXTENT IT IS SCORIACEOUS. IT IS A VERY BLACK BASALT AND ITS WEATHERING COLOR IS RUSTY BROWN, NOT GREY.

THIS BASALT CONSTITUTES A CLIFF ALONG THE LAKE FOR HALF A MILE. ABOVE IT AND FARTHER BACK ARE OTHER LEDGES OR SEMI-CLIFFS WHICH IN THE AGGREGATE REACH 350 FEET ABOVE THE LAKE, ALL OF IT BASALT. THESE CLIFFS CONSTITUTE THE WEST SIDE OF THE LAKE VALLEY. THE EAST SIDE CONSISTS WHOLLY OF GNEISS— THERE IS NO TRACE OF BASALT. AND GOOD AUTHORITY— AN INDIAN GUIDE WHO KNOWS THE DIFFERENCE BETWEEN BASALT AND GNEISS AND WHO HAS MADE MOST OF THE TRAILS ON THIS UPLAND— SAYS THAT THERE IS NOTHING BUT THE GNEISS EAST TO THE SUMMIT OF BUCK HILLS.

NOW IT SEEMS IMPOSSIBLE THAT THE BASALT ON THE WEST SIDE OF THE LAKE SHOULD REMAIN IN STEEP CLIFFS WHILE ITS FORMER EXTENSION ACROSS TO THE FLANKS OF BUCK MTN. SHOULD LOSE ALL TRACE OF BASALT. ESPECIALLY SINCE THIS PLATEAU HAS SUCH GENTLE GRADIENTS AND ON THE MARGINS, PITCHES OFF STEEPLY INTO THE HEADS OF HIGH-GRADIENT DRAINAGE LINES. AN INTERPRETATION MUCH TO BE PREFERRED IS THAT THIS WESTERN SLOPE OF IDEAL LAKE IS A CONSTRUCTIONAL SLOPE, AT LEAST IN LARGE PART. THE LAVA FLOWS NEVER EXTENDED FARTHER EAST.

SEVERAL PROMINENT ELEVATIONS BETWEEN IDEAL LAKE AND HADDO LAKE, TWO OR THREE ARE ROUNDISH HILLS 200 TO 300 FEET HIGH. TWO CASES OF CLIFFS WHICH, WITH TALUS RECHONED IN, ARE 150 TO 250 FEET HIGH. ALL OF THESE ARE OF BASALT, ONLY A FEW KNOBS OF DODER ROCK OUTCROPPING IN THE LOWER PLACES AMONG THEM. THEY ARE LAVA CONES, LIKE THE LARGER ONE NEAR ABERDEEN LAKE. THIS LARGER ONE APPEARS TO BE WIDER THAN ORIGINALLY ESTIMATED. IT HAS A GENTLER WESTERN SLOPE, A SLOPE WHICH BECOMES STEEPER AS IT COMES TO THE WALL OF DUTEAU CREEK. PERHAPS A SECTION SHOWING THE BASE OF THE BASALT MIGHT BE FOUND IN THE WALL OF THIS CREEK VALLEY.

THE BASALT IN THE HILLS ABOUT WOLASTON LAKE HAS HUGE COLUMNS, THREE OR FOUR FEET IN DIAMETER. THEY STAND PERPENDICULAR AND DETERMINE VERTICAL WALLS. THERE IS MINOR HOINTING IN EACH COLUMN BUT VERY LITTLE, IF ANY, PLATINESS.

THIS BASALT HAS SOME REMARKABLE SEGREGATIONS OF OLIVINE IN SOME PARTS OF IT. MOST OF THEM ARE ABOUT AN INCH OR TWO IN DIAMETER BUT SOME ARE 3 OR 4, AND ONE WAS FOUND 2X6X8, ALL PURE GRANULAR CHRYSOTILE. ONE SEGREGATION, COMPOSED OF PLAGIOCLASE, WITH A FEW XLS OF RUTILE OR ILMENITE. VERY LITTLE SCORIACEOUS TEXTURE; THAT WHICH IS PRESENT IS COMMONLY FILLED WITH MILKWHITE CHALCEDONY.

NORTHERN NOSE OF THE HILL EAST OF WOLASTON LAKE IS STRONGLY GLACIATED THO THERE IS VERY LITTLE GROOVING AND FURROWING. STRIAE STRIKE S 5 TO 10°E

#### VICINITY OF IDEAL LAKE AUGUST 11 1926

BASALT/BLUFF WEST OF THE LAKE CLIMBED. IT IS NOT BASALT FROM BOTTOM TO TOP (ABT 350 FT). THE BASALT IS REALLY A VENEER, THICK IN PLACES, THIN IN OTHERS, ABSENT IN SOME. THE DENSE FOREST MAKES AN EXAMINATION VERY DIFFICULT AND VERY UNSATISFACTORY. BUT THE SHUSWAP GNEISS IS A COMMON OUTCROP AT THE TOP OF THE SLOPE. THIS RELATIONSHIP SEEMS TO BE THE RULE ON THE PLATEAU— THE BASALT IS NOT THICK ANYWHERE EXCEPT IN THE CONES, AND NOT VERY THICK EVEN THERE. THE CONE EAST OF WOLASTON LAKE APPEARS TO BE OF BASALT ALL THE WAY DOWN THE EAST SLOPE BUT HAS SHUSWAP ROCK LEDGES ON THE WEST SIDE AT LEAST 150 FEET ABOVE THE BASE.

CURIOS THAT MOST OF THE CONES ARE CLIFFED ON THE EAST

UP IN THE WOODS ABOUT AT THE TOP OF THE SLOPE AND SOUTH OF THE LARGE CREEK WHICH ENTERS THE LAKE OUTLET HALF A MILE BELOW THE DAM, IS A REMARKABLE BASALT HILL. IT IS 60-70 FEET HIGH IN MAXIMUM HEIGHT, IS LINEAR IN SHAPE, ABOUT 500 FEET LONG AND HAS SLOPES OF  $30^{\circ}$  AND  $35^{\circ}$ . IT IS ALL BROKEN BASALT TALUS TO THE RIDGE CREST. THERE IS NO SOIL AND NO FOREIGN ROCK FRAGMENTS WERE FOUND.

THE RIDGE SETS ON AN IRREGULAR PLATFORM OF HEAVILY GLACIATED BARE GNEISS. ON THIS GNEISSIC PEDIMENT ARE A FEW HUGE BOULDERS OF BASALT, COMPOSED OF CLUSTERS OF COLUMNS, WHICH HAVE CLEARLY ROLLED OUT THERE ON THE GLACIATED SURFACE BY REASON OF THEIR GREATER MOMENTUM THAN THAT POSSESSED BY SMALLER FRAGMENTS. THE WHOLE TALUS HAS GROWN OUT ON THE GLACIATED GNEISS.

NOW THE RIDGE IS ORIENTED NEARLY EAST-WEST, WHILE THE GLACIAL ICE MOVED FROM THE NORTH. AND THE ONLY WAY BY WHICH THE GNEISS COULD BE STRONGLY GLACIATED BY WISCONSIN ICE AND THE RIDGE COULD BE DRIFT-FREE AND STAND ON THE GNEISS PLATFORM, IS TO BUILD THE RIDGE AFTER THE WISCONSIN GLACIATION. THIS MEANS, THEN, THAT VULCANISM HERE, AS AT COOKSON, POSTDATES GLACIATION— AND STRENGTHENS THE ARGUMENT THAT THE MAIN PERIOD OF VULCANISM ON THIS PLATEAU WAS PLEISTOCENE.

THE BASALT OF THIS LINEAR POST-GLACIAL (?) EXTRUSION HAS PHENOCRYSTS OF A DARK FELDSPAR OR A LIGHT PYROXENE OR AMPHIBOLE. NO OTHER BASALT SEEN ON THE PLATEAU HAS THIS CHARACTER. FOR HALF A MILE SOUTH OF THIS HILL (EXCEPTING THE BARE GNEISS IMMEDIATELY SOUTH) THE DRIFT CONTAINS A LARGE PROPORTION OF THIS LAVA. IT SEEMS CLEARLY TO HAVE COME FROM THE HILL. IF IT DID, THE HILL IS NOT POSTGLACIAL UNLESS THERE HAS BEEN RENEWED EXTRUSION OF THE SAME KIND OF LAVA FROM THE SAME VENT. IF THE HILL REALLY IS PREWISCONSIN, THE ABSENCE OF ERRATICS MAY BE ASCRIBED TO POST-GLACIAL BREAKING UP OF THE BASALT, BUT THE SMOOTHED GNEISS IMMEDIATELY SOUTH OF THE STEEP LITTLE HILL SEEMS VERY DIFFICULT TO EXPLAIN UNLESS BY SOME POSSIBILITY THIS SMOOTHING DATES BACK TO THE SPOKANE GLACIATION.

THE REMARKABLE SHARPNESS OF FORM AND SHARP LIMITATION OF DISTRIBUTION OF THE BASALT INDICATE THIS HILL TO BE CONSTRUCTIONAL, NOT EROSIONAL IN ORIGIN. IT IS A VERY VISCID EXUDATION OF ~~THE~~ REMARKABLY LIMITED EXTENT. ITS ORIGIN AS SUCH POINTS TO THE ORIGIN OF THE PRE-WISCONSIN BASALT HILLS OF THE PLATEAU AS SIMILAR FEATURES, AND WEAKENS THE INTERPRETATION OF THESE FEATURES AS EROSIONAL REMNANTS OF A MUCH OLDER AND FAIRLY COMPLETE COVER.

THE UPLAND AT 4500, 5000 AND 5500 WEST OF THE ROAD TO IDEAL LAKE IS ALL SHUSWAP GNEISS. ITS SLOPES ARE GENTLE, AS BEFITS THE UPLANDS OF AN OLD LAND. CLIFFS IN GNEISS ARE VERY RARE AND WHERE PRESENT ARE INCONSPICUOUS AFFAIRS ON THE PLATEAU, WHILE MOST EVERY BASALT AREA HAS ONE PROMINENT CLIFFED MARGIN, PERHAPS MORE.

A BASALT CONE, WITH EASTERN CLIFF, FACING MISSION CREEK VALLEY STANDS AT 4600 AT 2 MILES SOUTH OF THE NORTHERN MARGIN OF THE KETTLE VALLEY SHEET AND ABOUT ONE MILE WEST OF MISSION CREEK AND THE IDEAL LAKE ROAD. THE CONVENTIONAL LARGE COLUMNS IN VERTICAL POSITION ARE EXPOSED ABOVE THE ~~LARGE~~ LARGE ACCUMULATION OF TALUS. NORTHERN SLOPE OF THE HILL IS SMOOTHED BY GLACIAL EROSION. THE EASTERN LIMIT OF BASALT HERE IS THE EDGE OF THE TALUS— THE SHARP LIMITATION BEING LIKE THAT ELSEWHERE. THE HILL IS ABOUT 100 FEET HIGH.

ANOTHER BASALT HILL, 150 FEET OR SO HIGH, STANDS BETWEEN THE TWO OUTLETS OF THE LAKE RESERVOIR. IT HAS A STEEP WESTERN FRONT AND A STEEP EASTERN FRONT, AND A BASEMENT OF GNEISS, FAIRLY PLANE. THE MAIN OUTLET (THE WESTERN ONE) CUTS INTO THE WESTERN FLANK AND APPARENTLY A PART OF THE LAVA CONE LIES WEST OF THE CREEK. OUTCROPS OF A VOLCANIC AGGLOMERATE ARE JUST ABOVE THE ROAD NORTH OF THE CREEK. THIS AGGLOMERATE CONTAINS FRAGMENTS OF NON-VOLCANIC MATERIAL WHICH MUST BE

COLLECTED AND IDENTIFIED. SEVERAL GOOD XLS OF A TRANSPARENT MINERAL WITH GOOD CLEAVAGE, HARDER THAN STEEL. IT MAY BE TOPAZ. THIS IS A QUEER COMBINATION— CRYSTALS AN INCH IN DIAMETER IN A VOLCANIC AGGLOMERATE. THE MATERIAL IS CLEARLY ASSOCIATED WITH THE BASALTIC EXTRUSION.

DRIFT TERRACES ALONG MISSION CREEK VALLEY FOR TWO OR THREE MILES SOUTH OF THIS BASALT HILL ARE VERY REGULAR, LIKE GREAT TREADS OF A VERY WIDE STAIRCASE.

COLUMNAR BASALT IN CLIFF ABOUT 1 1/2 MILE EAST OF THE BASALT HILL BETWEEN THE LAKE OUTLET FORKS, AND ON THE EAST SIDE OF THE CREEK FROM THE EAST SIDE OF THE ROUND GNEISS HILL. LOOKS LIKE A VENEER, SIMILAR TO THAT WEST OF IDEAL LAKE. ALL TOLD, 12 SEPARATE EXTRUSIONS OF BASALT HAVE BEEN FOUND FROM COOKSON TO ABERDEEN LAKE AND THERE MAY WELL BE AS MANY MORE IN THE WOODS COVERING THE DISTRICT ENTERED. YET THIS SEEMS INADEQUATE TO EXPLAIN THE SPOKANE FLOOD, FOR ALL WOULD NEED TO BE CONTEMPORANEOUS—I.E. WITHIN THE SAME WEEK OR MONTH, AND EVEN IF SO, COULD NOT MAINTAIN THE FLOOD FOR MORE THAN A FEW DAYS OR WEEKS, UNLESS WALLULA COMPUTATIONS ARE IN ERROR, OR UNLESS MUCH MORE THAN 50% OF THE WATER CAME FROM MELTING OUTSIDE THE LIMITS OF THE VOLCANIC FIELD.

THE SEEMINGLY REQUIRED GREATER AREA OF LAVA FLOWS MUST LIE IN THE UNSURVEYED COUNTRY OF THE KETTLE RIVER DRAINAGE OR IN THE EXTENSIVE "MIOCENE" BASALT NORTHWEST OF THE HEAD OF OKANOGAN LAKE AS FAR AS THE SOUTH THOMPSON VALLEY. THIS SHOULD BE VISITED.

IDEAL LAKE TO KELOWNA AUG. 12 1926

THE FRAGMENTS OF NON-VOLCANIC MATERIAL IN THE AGGLOMERATE A MILE SOUTH OF THE LAKE, JUST NORTH OF THE ROAD BRIDGE OVER THE OUTLET, INCLUDE QUARTZITE AND GNEISS AMONG THE IDENTIFIABLE PIECES. ALL ARE SMALL, FROM A FRACTION OF AN INCH TO 1 1/2 INCHES MAX. DIA. THEIR OUTLINES ARE NOT SUGGESTIVE EITHER OF PIECES DERIVED FROM CONDUIT WALLS OR FROM UNDERLYING DRIFT. THEY CONTRIBUTE NOTHING TO THE SOLUTION OF THE PROBLEM.

BLACK KNIGHT MTN HAS A HEAVY CAP OF IGNEOUS ROCK ON A VERY MUCH SHATTERED, APPARENTLY SILICEOUS GREEN METAMORPHIC WHOSE ORIGINAL NATURE IS DIFFICULT TO NAME. THIS IGNEOUS ROCK LOOKS MUCH LIKE THAT OF CAMEL'S HUMP. IT IS A LAVA WITHOUT GOOD COLUMNAR STRUCTURE, MASSIVE IN THE CLIFFS, WHITE OR GRAY ON FRESHLY EXPOSED SURFACE. THE FACES EXPOSED TO THE WEATHER ARE BLACKENED BY MINUTE LICHENOUS INCRUSTATIONS. THE FORM OF THE MOUNTAIN AND THE FACT THAT THE BASEMENT ROCK EXENTS WELL UP ON THE FLANKS (PROBABLY ABOUT 3/4 OF THE MOUNTAIN'S ALTITUDE ABOVE KELOWNA) INDICATE THAT A GREAT DEAL OF EROSION HAS OCCURRED SINCE THE EFFUSION OCCURRED. A MUCH LOWER HILL ALONG THE NORTH BLUFF OF MISSION CREEK AND FARTHER DOWNSTREAM THAN BLACK KNIGHT MTN. HAS A STRIKING EXPOSURE OF THIN BASALT (OR COLUMNAR LAVA) FLOWS, EACH FLOW AVERAGING 10-15 FEET THICK. THE FLOWS IN THE WEST END OF THE HILL ARE BENT; IN THE EAST PART THEY ARE HORIZONTAL. THEY ARE LOWER THAN THE ADAMS LAKE OR NISCONLITH SERIES EXPOSED ON THE SOUTHERN WALL OF THE CRBBK VALLEY AND PROBABLY ARE SUBSEQUENT TO THE EARLIEST DISSECTION OF THE PENEPLAIN BUT THEY ALSO APPEAR MUCH ERODED AND CANNOT ENTER INTO THIS PROBLEM OF THE SCABLAND FLOOD.

VERNON TO RED PILLARS AUGUST 13 1926

THE BASALT HILL WEST OF VERNON SHOWS A CONSIDERABLY SHEARED, SLICKENSIDED, BRECCIATED BLACK BASALT WHICH IN ITS ORIGINAL FORM WAS AGGLOMERATIC. IT CLEARLY HAS BEEN DEFORMED AND MUCH ERODED. THO IT LIES DOWN IN ONE OF THE MAJOR VALLEYS OF THE INTERIOR PLATEAU AND THEREFORE

IS POST-SPOKANE PENEPLAIN, IT SURELY IS PRE-SPOKANE.

THE BASALT UP SALMON RIVER ABOVE GRAND PRAIRIE IS SPLENDIDLY SHOWN IN THE GORGE-LIKE VALLEY'S WALLS. A THICKNESS OF 2000 FEET OF NEARLY HORIZONTAL FLOWS, LAYERS OF AGGLOMERATE AND SCORIAEUS AND BOMBY PHASES SHOWN. RED IS A COMMON COLOR, DUE TO HIGH OXIDATION, PROBABLY, AT THE TIME OF EXTRUSION. THE DENSE BASALT IS BLACK. SOME PARTS OF THE SERIES ARE TILTED 15° OR MORE, SOME SHOW SHEARING BUT ALL TOLD, THERE IS VERY LITTLE DEFORMATION.

YET THE GREAT DEPTH OF THE VALLEYS AND THE ADVANCED DEGREE OF DISSECTION OF THE BASALTIC PART OR THE PLATEAU HERE ARGUE THAT THE LAVA IS TERTIARY, NOT QUATERNARY, IN AGE. OTHERWISE, THE EROSIONAL VALLEYS ALL OVER THE PLATEAU WOULD HAVE TO BE CLASSIFIED AS PLEISTOCENE IN AGE.

YET ALL THE BASALTS SHOWN ON DAWSON'S MAP THAT HAVE BEEN EXAMINED THUS FAR ARE DOWN IN VALLEYS IN THE BASEMENT ROCK OF THE PLATEAU. EITHER THE PENEPLAIN IS POST-BASALT AND THE BASALT WAS POURED OUT ON AN ERODED SURFACE, HAPPENING TO FILL ALL THE VALLEYS, *or the basalt is pre-peneplain and has been warped down into its present position in the valleys,* OR THERE WERE STRUCTURAL DEPRESSIONS OR EROSIONAL VALLEYS, LATER THAN THE PENEPLAIN, INTO WHICH THE BASALT WAS POURED, AND THE PRESENT SYSTEM OF VALLEYS IS A STILL LATER DEVELOPMENT. IT IS DIFFICULT TO SAY FROM PRESENT KNOWLEDGE WHICH OF THESE THREE EXPLANATIONS IS CORRECT.

A PROMINENT SILT TERRACE WEST OF GRAND PRAIRIE ABOUT 300 FT ABOVE THE PRAIRIE AND AS THICK AS HIGH. ITS SUMMIT MUST BE 2250 OR 2300 A.T.

VICINITY OF SWALWELL (BEAVER) LAKE, AUG. 14 1926

WRINKLY FACE MTN. HAS ONLY BASALT EXPOSED IN ITS CLIFFS. THE GREAT VENEER OF DRIFT MOUNTS ALMOST ALL THE WAY TO THE BRINK OF THE WESTERN CLIFFS WHERE THE TRAIL ASCENDS BUT IN THE NORTHERN PART OF THE MT FRONT, THE BASALT IS EXPOSED IN A SUCCESSION OF FLOWS FOR A THICKNESS OF 1500 FT. THE NAME OF THE MT. IS DERIVED FROM THE ASPECT OF THE PREVAILING COLUMNAR STRUCTURE. COLUMNS ARE LARGE, IRREGULAR AND PLATY. NO SCORIAEUS OR VESICULAR PHASES SEEN ANYWHERE. THE PLATINESS IS NOT STRONGLY MARKED BUT IS VERY PERSISTENT AND CLOSELY SPACED AND UNIFORMLY ORIENTED. IT LOOKS SUSPICIOUSLY LIKE SCHISTOSITY IN ITS INCIPENT PHASES.

BELOW THE BASALT IS A PORPHYRITIC GRANITE WITH LARGE ORTHOCLASE PHENOCRYSTS. THIS BLUE-BLACK, DENSE, COLUMNAR BASALT EXTENDS FROM WRINKLY FACE BACK INTO THE VALLEY OF SWALWELL LAKE WHERE IT APPEARS TO CONSTITUTE THE PLATEAU-LIKE LEVEL COUNTRY, MARGINING THE LAKE ON BOTH EAST AND WEST. A SHOULDER OF ROCK ON THE WEST END OF THE LAKE ALONG THE TRAIL STANDS 300 FEET OR MORE ABOVE THE WATER AND FROM IT THE REMARKABLE PLANENESS OF THIS PART OF THE PLATEAU CAN BE WELL SEEN. I AM ASSURED BY A PROSPECTOR THAT BASALT UNDERLIES ALL THE PLANE TRACT. THE SHOULDER ITSELF SHOWS A BASALT IDENTICAL WITH THAT IN THE FACE OF WRINKLY. IT IS WELL ROUNDED BY GLACIAL ICE, THO SUBSEQUENTLY FRACTURED BY FROST. ALTITUDE OF THE BASALT ON THE WEST END OF THE LAKE IS ABOUT 4800, ABOUT 100 FEET HIGHER THAN THE BRINK OF WRINKLY FACE. FARTHER UP THE TRAIL TO LONG (ALEC'S OR ALEX.) MTN, NOTHING SEEN BUT GNEISS, AND DAVE, THE OLD INDIAN GUIDE, SAYS THE MT. SUMMIT IS ALL "GRANITE", NOT THE BLACK ROCK.

THERE IS A THRU VALLEY FROM SWALWELL LAKE TO ABERDEEN LAKE DRAINAGE, THE COL IN WHICH IS BELOW 4600. SWALWELL ITSELF IS A LITTLE ABOVE 4400. THE BASALT FLOWS WHICH DETERMINE THIS PLANE TRACT ON THE PLATEAU HAVE SUFFERED EROSION TO THE DEPTH OF NEARLY 400 FEET TO MAKE THE VALLEY OF SWALWELL LAKE.

FURTHERMORE, THE UPPER PART OF THE LONG LAKE VALLEY SLOPES SOUTH OF THE TRAIL ARE OF BASALT. THE THICK FLOWS ARE TERMINATED ABRUPTLY BY THE BLUFFS AND CLIFFS. AS THO THE FLOWS WERE OLDER

THAN THE VALLEY. THE SURFACE OF THE LAND WHEN THE FLOWS OCCURRED WAS OF GRANITE AND ABOUT 1500 FEET ABOVE THE PRESENT FLOOR OF THE VALLEY.

A PROSPECTOR HAS OPENED AN UNUSUAL GRAVEL DEPOSIT IN SEC. 18 OF Tp. 21, AT THE FOOT OF THE BASALT IN WRINKLY FACE, IN SEARCH FOR PLACER GOLD. THE GRAVEL HAS A CONSPICUOUS CONSTITUENT IN ABUNDANCE—WHITE TO SEMI-TRANSPARENT QUARTZ. THIS IS RARE IN THE DRIFT. INDEED, THE GRAVEL IS VIRTUALLY ALL SILICEOUS MATERIAL. SUCH IGNEOUS ROCK AS IS PRESENT IS MUCH DECOMPOSED AND THE SAND AND CLAYEY MATERIAL OF THE GRAVEL ARE NOTABLY TALCY. THE COLOR IS ALMOST <sup>WHITE</sup> FOR THE MOST PART. STRATIFICATION PRESENT.

THERE IS GRANITE OUTCROPPING BELOW THE GRAVEL HORIZON THO A FEW 100 FEET OFFSIDE. BASALT IS IN PLACE 20 FEET OR SO ABOVE THE GRAVEL. THIS IS A PREGLACIAL GRAVEL OF THE PREBASALT LAND SURFACE, AND WITH THE EROSIONAL FEATURES AND THE THICKNESS AND THE TOPOGRAPHIC RELATIONS ABOVE NOTED, IT POINTS TO A LATE TERTIARY AGE FOR THE BASALT. THE PLAINNESS WHICH IS REMARKABLY UNIFORM AND ACTUALLY LOOKS LIKE STRATIFICATION ON WEATHERED SURFACES OF THE NON-COLUMNAR PHASES, DIPS BACK INTO THE HILL SLOPE. WHY THIS SHOULD BE SO IS NOT CLEAR.

VICINITY OF MYRA AUG. 15 1926

THREE BASALT-COVERED AREAS, ALL SMALL, FOUND HERE. ALL ARE EXCEPTIONALLY INTERESTING.

ONE TRACT EXTENDS DOWN THE SLOPE BELOW MYRA ALONG THE OLD ROAD FROM THE IRRIGATION CANAL. IT IS A RIDGE WHICH BIFURCATES DOWN HILL AND BECOMES TWO RIDGES TOWARD THE TERMINUS. ITS LENGTH MUST BE MORE THAN 1000 FEET. ITS BROAD CREST DESCENDS 80 FEET OR A LITTLE MORE IN THAT DISTANCE. ITS HEIGHT ABOVE THE ADJACENT SLOPE IS ONLY A FEW FEET AT THE UPPER END BUT NEARLY 100 FEET AT THE DOWNHILL TERMINUS OF THE LARGER ARM. NOTHING BUT THE SHUSWAP GNEISS IS EXPOSED ON EITHER SIDE AND THERE ARE NO RAVINES OR SPURS OR OTHER COMPARABLE RELIEF OF THE GNEISSIC SURFACE. THIS BASALT RIDGE CLEARLY IS A TRICKLE FLOW DOWN THE EXISTING MT. SLOPE, A TRICKLE THAT STARTED NEAR THE RR TRAX AND THICKENED LIKE A CONGEALING FLOW OF WAX TOWARD THE LOWER END. THE PERFECTION OF THE FORMS IT NOW STANDS PROOVES THIS FLOW TO HAVE BEEN LATE PLEISTOCENE. IT IS PRE-WISCONSIN, HOWEVER, AND BEARS STRIAEE WHICH STRIKE S 5-10° E.

ANOTHER SMALL AREA OF BASALT IS CUT BY THE RR EXCAVATIONS HALF A MILE WEST OF THE STATION OF MYRA. INDEED, THIS BASALT MAY BE THE SOURCE OF THE TRICKLE BELOW THE TRAX. THE RR CUT SHOWS THREE FLOWS, THE LOWER TWO POSSESSING THE SCORIACEOUS UPPER PART BELOW THE HEAVY COLUMNS OF THE BASAL PART OF THE NEXT FLOW ABOVE. THERE IS MUCH SCORIACEOUS AND AGGLOMERATIC MATERIAL IN THE LARGE BLEBS, A FEW FEET IN DIAMETER, SCATTERED THRU THE DENSE COLUMNAR MATTER. THE BASALT IS A BLUE BLACK IN COLOR AND THERE IS NO WEATHERING, OTHER THAN A GRAYNESS OR BROWNNESS ALONG JOINTS, IN THE LAVA. TOTAL THICKNESS EXPOSED IS BUT LITTLE SHORT OF A HUNDRED FEET.

THIS BASALT A HALF MILE WEST OF MYRA RESTS ON A DEEPLY REDDENED PHASE OF THE SHUSWAP GNEISS, THE UPPER SURFACE OF WHICH IS DECOMPOSED TO A FINE MANTLE ROCK. THERE IS NO SIGN OF ANY DEPOSIT BETWEEN THE TWO.

THE THIRD EXPOSURE OF BASALT IS THE LARGEST OF ALL. IT IS IN THE SPUR BETWEEN KLO CREEK AND ITS TRIBUTARY POOLEY (?) CREEK. IT OCCURS ON BOTH SIDES OF KLO CREEK ABOVE THE RAILROAD AND, IN THE SECTION, EXTENDS TO THE TIP OF THE SPUR. IT IS SIMILAR TO THAT CLOSE TO MYRA EXCEPT THAT SCORIACEOUS PHASES ARE NOT WELL SHOWN. BOTH ARE FLOWS FROM THE FLATTISH HIGHER LAND TO THE SOUTH AND THEY OCCUPY ESSENTIALLY LOWLANDS WITH REFERENCE TO THE HIGHER ROUNDED SUMMITS LIKE LITTLE WHITE MT.— THO OF COURSE THE DEEP CANYONS, NEARLY 1000 FEET BELOW THE

BASALT, ARE NOT TO BE CONSIDERED IF SUCH A COMPARISON IS MADE. IN OTHER WORDS, IT LOOKS AS THO THE CANYON OF KLO CREEK HAD NOT BEEN CUT WHEN THE BASALT WAS Poured OUT.

BENEATH THE BASALT IS A COARSE COBBLY GRAVEL, WITH BLDRS., POORLY STRATIFIED OR UNSTRATIFIED FOR A MAXIMUM THICKNESS OF 30 FEET. BENEATH THE GRAVEL IS THE SHUSWAP GNEISS, VERY MUCH DEGRADED LIKE THE GRAVEL ITSELF.

THE COBBLE GRAVEL CONSISTS ENTIRELY OF THE VARIOUS PHASES OF THE SHUSWAP, SO FAR AS COULD BE DETERMINED. GNEISS, SCHIST, GRANITE, VEIN QTZ., ALL ARE ABUNDANT. APPARENTLY THIS VERY COARSE DEBRIS BENEATH THE BASALT IS ENTIRELY OF LOCAL DERIVATION. AND THERE IS NO BETTER EVIDENCE THAN THE SUBANGULARITY OF FRAGMENTS AND THE LACK OF STRATIFICATION THAT THE DEPOSIT IS OF GLACIAL OR GLACIOFLUVIAL ORIGIN.

A SOIL OR ZONE OF MANTLE ROCK CLAY AND SAND ABOUT 3 OR 4 FEET THICK COVERS THE TOP OF THE COBBLE GRAVEL. IT IS SO MUCH DECOMPOSED THAT ONLY SMALL PIECES OF VEIN QTZ PEBBLES ARE IDENTIFIABLE IN THE CLAY. REMAINS OF ROOTS FOUND IN THIS SOIL. OBVIOUSLY, THEREFORE, THE DECAY OF THE COBBLE GRAVEL AND ITS UNDERLYING GNEISS, BOTH OF WHICH ARE MARKED, OCCURRED BEFORE THE BASALTIC EXTRUSION. AND IT IS EQUALLY OBVIOUS THAT A MANTLE OF VEGETATION COVERED THE SOIL WHEN THE LAVA FLOW CAME.

IN OTHER WORDS, THERE IS HERE ONLY A COARSE, LITTLE WORN, COBBLY ACCUMULATION OF LOCAL WASTE, THAT ANTE-DATES THE CANYONING OF KLO (CANYON) CREEK, THAT RECORDS SUFFICIENTLY STEEP SLOPES TO YIELD COBBLES AND BLDRS., AND THAT WAS DEGRADED ENOUGH TO HAVE 3 FEET OF RESIDUAL SOIL WHEN THE VOLCANIC ACTIVITY OCCURRED. NO GLACIAL CLIMATE IS RECORDED AT ALL. THIS BASALT STREAM OR FLOW DID NOT EMERGE BENEATH AN ICESHEET. YET IT IS PROBABLY OF PLEISTOCENE AGE.

GNEISS UNDER THE WISCONSIN TILL IN RR CUTS IS WEATHERED ABOUT LIKE THE GRANITE UNDER TILL NEAR COOKSON. THIS IS A LITTLE SURPRISING FOR MYRA IS ON A NORTH SLOPE UP WHICH THE WISCONSIN BASAL ICE CLIMBED ABOUT 3000 FT AS SHOWN BY STRIAe ON THE LOWER BASALT TONGUE OR TRICKLE. IT MAY BE NOTED HERE ALSO THAT THE GRANITE WITH ORTHOCLASE PHENOCRYSTS WHICH PRESUMABLY UNDERLIES THE QTz GRAVEL ON THE WEST SLOPE OF WRINKLY FACE ALSO IS CONSIDERABLY DISINTEGRATED BENEATH FRESH WISCONSIN TILL.

KELowna to Tonasket AUG. 16 1926

REPORTED FROM TWO SOURCES THAT THE BENCHES OF "VOLCANIC ASH" (THE WHITE SILT) ARE TO BE FOUND ALONG OKANOGAN LAKE NORTH OF KELowna TO THE HEAD OF THE LAKE. THEY CANNOT BE CONTINUOUS, HOWEVER. THEY ARE NOT CONTINUOUS EVEN SOUTH OF KELowna.

THE SIDE-HILL GASHES BETWEEN WESTBANK AND PEACHLAND AND ALONG THE WEST SIDE OF DOG (SKAH) LAKE ARE VERY PROBABLY OF THE CATEGORY OF ROCK KNOBS AND HILLS PRODUCED BY GLACIAL PLUCKING. THEY ARE TOO WIDE AND FLARING TO BELONG TO THE GROUP WHOSE BEST EXAMPLES ARE EAST OF COOKSON. THEIR SLOPES SUGGEST AN AGE AS GREAT AS OTHER VALLEY SLOPES IN THEIR VICINITY.

INDEED, THE WHOLE WEST SIDE OF OKANOGAN VALLEY FROM THIS LATITUDE SOUTWARD INTO WASHINGTON IS CHARACTERIZED BY KNOBS AND RIDGES AND SHORT VALLEYS AND BASINS. THE VALLEYS ARE ELONGATED PARALLEL WITH THE OKANOGAN IN GENERAL, AND SURELY HAVE CARRIED WATER. BUT THAT WATER MAY HAVE BEEN ONLY LATERAL WISC. DRAINAGE, OR IT MAY HAVE BEEN POST-GLACIAL AND INTERGLACIAL DRAINAGE AS WELL, AND IT MAY ALSO HAVE BEEN SPOKANE LATERAL OR SUBGLACIAL.

CAMSELL'S CONCEPTION OF AN OLD TERTIARY VOLCANO, BROKEN DOWN NOW INTO RUGGED CRAGGY HILLS AND ~~AND~~  
BASINS AMONG THEM, IS UNQUESTIONABLY WRONG. ~~THE~~ THE BASINS ARE DUE TO DRIFT DAMS, NOT ROCK  
BARRIERS, AND THE SHORT CRAGGY HILLS ARE THESE HILLS OF GLACIAL PLUCKING AND EROSION. TILTED ~~SHALE~~  
SHALE WITH CARBONACEOUS SEAMS IN THEM ARE POOR MATERIALS FOR VOLCANIC CRATER WALLS. SHEARED AND  
FRACTURED LAVAS ALSO.

NOR COULD THE TOPOGRAPHY PRODUCED BY TERTIARY EXPLOSIONS BE EXPECTED TO SURVIVE TODAY. AND  
CAMSELL SAYS THE AGE IS PROBABLY OLIGOCENE!

ONE REASON FOR THE UNUSUAL AMOUNT OF SHORT HILLS AND SHALLOW VALLEYS IN THE VICINITY OF WHITE LAKE PERHAPS IS THAT THIS IS PROBABLY THE SITE OF A PREGLACIAL DIVIDE. THE NARROW VASEAUX LAKE GATEWAY WAS REMARKED LAST YEAR. ~~ALSO~~ THE TRAVERSE THIS YEAR FROM THE WEST SIDE OF DOG LAKE TO FAIRVIEW BY A ROAD WHICH CLIMBS SEVERAL HUNDRED FEET ABOVE OKANOGAN LAKE. IT IS A LOW UPLAND, FRETTERED WITH THESE CURIOUS RAGGED KNOBBY HILLS AND TRENCHED BY ONE DEEP CASH. WHY GLACIAL ICE SHOULD PLUCK OR BITE IN THIS FASHION TO PRODUCE THIS TOPOGRAPHY IS A PUZZLE. IT HARDLY SEEMS THAT VARIATIONS IN ERODABILITY OR PLUCKABILITY COULD BE SO IRREGULARLY DISTRIBUTED. THE SAME SITUATION SEEMS TO BE SHOWN IN SEVERAL OTHER PLACES SEEN DURING THE PAST FOUR WEEKS. IS THERE SOME ITEM IN THE MECHANICS OF AN ICESHEET, MOVING OVER A MOUNTAINOUS BASEMENT WHICH SHOULD BE UNCOVERED AND EXPLAINED, TO ACCOUNT FOR THIS?

#### TONASKET TO BONAPARTE CREEK AUG. 17 1926

OKANOGAN VALLEY AT TONASKET HAS HUGE TERRACES ON BOTH SIDES, COMPOSED largely OF SILT ON THE EAST SIDE BUT WITH PLENTY OF GRAVEL STRATA INTERBEDDED. SOME GRAVELLY STRATA IN THE SILT TERRACES HAVE BEEN SEEN THIS SUMMER WHICH WERE COMPOSED OF ANGULAR TALUS FRAGMENTS OF LOCAL CLIFFS AND SHORES. THIS AT TONASKET, HOWEVER, IS TRUE GLACIAL GRAVEL. BLDS AND COBBLES IN THE SILT HERE, ALSO.

ON THE WHOLE, THE SILTS SEEN THIS SUMMER ARE EITHER VERY POORLY SEASONALLY BANDED OR TOTALLY LACKING IN VARVES. LAMINATION IN SOME STRATA IS PRONOUNCED BUT STRATA 2-3 FEET THICK WITHOUT LAMINAe SHOWING ARE NOT ~~SO~~ UNCOMMON. IT SEEMS PROBABLE THAT THE CLOSE PROXIMITY OF THE ICE FORBADE THE QUIET CONDITIONS REQUIRED FOR VARVE DEPOSITION. CONVECTION CURRENTS, CHANGES IN CURRENTS, CHANGES IN LEVELS, NARROWNESS OF WATER BODIES; ALL WOULD MILITATE AGAINST THE DEPOSITION OF VARVES.

THE NOTCHES ACROSS THE WESTERN END OF THE MT. ANNIE EMINENCE ARE VERY STRIKING FEATURES— CONSIDERABLY MORE SO THAN THE MAP INDICATES. THERE ARE TWO, AS SHOWN, BUT ONE HAS A DISTRIBUTORY CANYON SUBPARALLEL TO IT, AND THE ROCK SURFACES ADJACENT TO THE CANYONED NOTCHES IS ITSELF GREATLY ERODED AND SHAPED INTO SMALLER RIDGES AND CANYONS. THE SUMMITS IN THIS COMPLEX SEEM TO HAVE THE ROUNDED OUTLINES OF GLACIATED HILLS, THO THERE HAS BEEN A GREAT DEAL OF FRACTURING OF THE GNEISS IN POST-GLACIAL TIME. WALLS ARE VERY STEEP TO ACTUALLY VERTICAL AND EVEN OVERHANGING. VERTICAL CLIFFS 100 TO 200 FEET HIGH EXIST, THEIR FACES DETERMINED BY JOINT PLANES AND FAULT PLANES IN THE GNEISS. A CONSISTENT SOUTHWARD DESCEND TO THE CANYON FLOORS, NO BACK BASINS SEEN. COL IN EASTERN CANYON HAS A PEATY, WILLOW-COVERED LINEAR TRACT A THOUSAND FEET LONG IN THE CANYON BOTTOM. COL IS AT THE HEAD, THE NORTH END, OF THE CANYON.

THE TALUS IS VERY YOUNG. IN SOME PLACES, THERE IS NONE, IN OTHER PLACES BLOX OF GNEISS AS MUCH AS 30 FEET IN MAX. DIA. HAVE FALLEN INTO THE MIDDLE OF THE CANYON. NO DRIFT DEPOSITS IN CANYONS OR ON RIDGES AMONG THEM. RIDGES OR CLIFF SUMMITS ARE VERY IRREGULAR, DIVERSIFIED WITH

KNOBS AND SADDLES. SOME KNOBS HAVE A PRONOUNCED BACK SLOPE AWAY FROM THE BRINK.

FAULTING HAS NOT PRODUCED THESE CANYONED NOTCHES. THE GNEISS IS FAULTED IN PLACES BUT THE DISPLACEMENT IS LARGELY HORIZONTAL, AS SHOWN BY GOOD SLICKENSIDES. AND THE FAULTS CROSS THE CANYONS AT ANGLES AS HIGH AS  $18^{\circ}$  FROM THE TREND OF THE CANYON.

AT THE SOUTHERN END OF THE CANYONED NOTCHES ARE TERRACES OF TILL WITH AN ABUNDANCE OF LARGE BLDRS OF GNEISS FROM THE NOTCHES IN IT. SOME LOWER TERRACES ARE MORE LARGELY WASHED COARSE GRAVEL, ALSO WITH BOULDERS OF GNEISS. BOTH TILL AND GRAVEL TERRACES STAND ABOVE THE FLOOR OF THE NOTCHES WHICH OPEN THRU THEM OUT INTO AENEAS VALLEY, WELL ABOVE THE VALLEY FLOOR.

WATER—RUNNING WATER—MADE THESE NOTCHES. THEIR ORIGIN BY GLACIAL ICE DIRECTLY IS OBVIOUSLY IMPOSSIBLE. RUNNING WATER USED THEM DURING OR IMMEDIATELY AFTER THE BUILDING OF THE HIGHER DRIFT TERRACES OF AENEAS VALLEY. THESE TERRACES ARE WISCONSIN—LATE, LATE WISCONSIN.

BUT DID LATERAL DRAINAGE OF THE WANING WISCONSIN ICE IN BONAPARTE CREEK VALLEY TO THE WEST AND THE NORTH EVER MAKE THESE REMARKABLE CLEFTS DE NOVO? THE FIELD EVIDENCE DOESNT ANSWER. AND IT REMAINS FOR SUCH NOTCHES AS THOSE SOUTH OF DIAMOND LAKE TO SUPPORT THE SUBGLACIAL STREAM HYPOTHESIS, IF THAT HYPOTHESIS DESERVES FURTHER SUPPORT.

WAGONROAD COULEE CONTAINS A RATHER PROMINENT MARGINAL MORaine OF THE RETREATING WISC. ICETONGUE SILT IN THE MINOR VALLEYS ALONG BRIDGEPORT-MANSFIELD ROAD UP TO 500 FT OF THE ALTITUDE OF MANSFIELD. (A.T.) MARGIN OF PLATEAU HERE IS VERY MUCH BROKEN DOWN BY EROSION. NOT AT ALL LIKE THE WESTERN EDGE, WEST AND NORTH OF WATERVILLE.

GRAND COULEE AT AUGUST 19 1926

GRANITE HILLS NORTH OF STEAMBOAT ROCK CONSTITUTE GRANITE SCABLAND. EXCEPT IN MAGNITUDE, THEIR KNOBS AND THE NARROWER DEFILES AMONG THEM CLOSELY RESEMBLE THE PLEXUS ON THE LOWER WESTERN SPUR OF MT. ANNIE.

ROUNDED HILLS IMMEDIATELY NORTH OF THE NORTHERN RANGE OF GRANITE KNOBS ARE GRAVEL, NOT SILT, ORDER OF SUPERPOSITION OF SILT AND GRAVEL NOT PERFECTLY CLEAR HERE BUT BETWEEN STEAMBOAT ROCK AND COULEE CITY THE SILT IS CLEARLY LATER.

WHY IS THERE SO MUCH SILT IN GRAND COULEE NORTH OF COULEE CITY AND NONE AT ALL IN ANY OF THE COULEES OF THE SCABLANDS. NOT EVEN GRAND COULEE ITSELF SOUTH OF C.C. SPIRIT LEVELING IN GRAND COULEE NORTH OF C.C. MAY SHOW WHAT APPEARS TO BE TRUE FROM VISUAL INSPECTION ALONE, THAT THE BRINK OF GRAND FALLS BEFORE THE LAST STAGES OF DRY FALLS AND DEEP LAKE FALLS IS ACTUALLY HIGHER THAN THE FLOOR OF GRAND COULEE ABOVE THE FALLS, AND HIGHER EVEN THAN THE HIGHEST OF THE SILT TERRACES. THIS SITUATION, IF IT EXISTS, WOULD ACCOUNT FOR STANDING WATER FROM COULEE CITY NORTH, IN WHICH SILT MIGHT BE DEPOSITED, PROVIDING GLACIAL DRIFT OR GLACIAL ICE ITSELF, OR A VALLEY TRAIN, AT THE SAME TIME WAS BLOCKING THE COLUMBIA VALLEY TO THE WEST.

LEAF-BEARING BEDS OF VOLCANIC ASH RATHER MUCH REDDENED BY WEATHERING ARE EXPOSED ALONG THE HIWAY AT THE EXTREME NORTH END OF GRAND COULEE. ACTUAL CONTACTS ABOVE AND BELOW NOT OBSERVED BUT GRANITE OUTCROPS ALL DOWN THE SLOPE OF THE HIWAY LEVEL HERE AND BASALT OUTCROPS IN THE COULEE WALLS NOT TO EXCEED 50-100 FEET ABOVE THESE BEDS. THEY ARE VERY PROBABLY AKIN TO THE LATAH FORMATION BOTH IN CHARACTER AND CONDITIONS OF ORIGIN FOR A PROTECTING GRANITE RIDGE WHICH LAY BETWEEN THE SOURCE OF THE FLOWS (PRESUMABLY TO THE SOUTH) AND THE GRANITE UPLANDS NORTH OF THE PLATEAU IS PROVIDED BY THE TWO RANGES OF GRANITE HILLS ACROSS GRAND COULEE NORTH OF STEAMBOAT RK. CONSIDERABLE LENGTHS OF GR.COULEE WALLS ABOVE C.C. HAVE MUCH LESS THAN  $1/2$  TALUS.

COULEE CITY TO SPOKANE

AUG. 20 1926

SECTIONS ALONG THE SUNSET HIWAY EAST OF DAVENPORT MUST BE EXAMINED CAREFULLY FOR DATA ON SPOKANE AND CHENEY GLACIATIONS. WEATHERED ERRATICS, INCLUDING ONE NICELY STRIATED QTZITE PEBBLE, FOUND WITHIN THE LOESSIAL HILLS IN SMALL VALLEY ALONG HIWAY. MAY BE SPOKANE MATERIAL FLOATED IN (IT IS NOT TOO DISTANT) BUT MAY BE CHENEY TILL ENCOUNTERED BENEATH LOESS BY THE STREAM EROSION.

THE VICINITY OF DEEP CREEK TOWN AND EASTWARD TO SPOKANE SHOWS MUCH OF SPOKANE DRIFT NORTH OF THE SCABLAND CHANNEL HEADS. HIWAY EAST OUT OF DEEP CREEK CLIMBS 100 FT OR MORE OVER A BASALTIC SAND DEPOSIT WHOSE GENESIS IS NOT CLEAR.

THE SAME SCABLAND AS FOUND ON INDIAN PRAIRIE MARGIN ALONG SPOKANE RIVER BLUFFS IS TRAVESED BY THE SUNSET HIWAY NEAR THE BRINK OF THE RIVER VALLEY. ITS RELATIONSHIP TO THE SCABLANDS FARTHER SOUTH MUST BE DETERMINED, ALSO ITS RELATIONS TO DEPOSITS OF GROUND MORAINES.

SPOKANE TO MOYIE

AUG. 21

NO TILL TERRACES OR GRAVEL TERRACES HIGH UP ON THE MOUNTAIN SIDES RECOGNIZED IN THE ENTIRE TRAVERSE. PLENTY OF DRIFT IN PLACES IN VALLEY BOTTOMS AND LOWER SLOPES, BUT NOT TERRACED EXCEPT AS DEFINITE VALLEY TRAINS. NO SILT SEEN FROM BONNERS FERRY TO MOYIE. NO SIDEHILL GASHES OR NOTCHES. NO ROCK KNOBS IN VALLEY BOTTOMS NORTH OF BONNERS FERRY EXCEPT ONE PROMINENT AFFAIR ABOUT TEN MILES FROM MOYIE. THIS IS 200 TO 300 FEET HIGH, ELONGATED WITH THE VALLEY LENGTH, AND STANDS ALMOST AT MID-VALLEY. IF IT WERE PLACED CLOSELY ADJACENT TO ONE VALLEY WALL, IT WOULD DUPLICATE A SIDE-HILL GASH IN FORM, EXCEPT FOR ITS LOW POSITION IN THE VALLEY. IT MUST RECORD GLACIAL DEEPENING, PROBABLY BY PLUCKING, TO THE EXTENT OF ITS OWN HEIGHT.

ROCK KNOBS IN THE MIDDLE OF THE COCOLALLA VALLEY AT THE WISCONSIN TERMINAL MORaine (GRANITE STATION) LOOK VERY SIMILAR TO THOSE FOUND ELSEWHERE IN B.C. AND AScribed TO GLACIAL PLUCKING. THEY SURELY HAVE BEEN MUCH ERODED BY GLACIAL ICE, BUT JUST AS SURELY DO NOT RECORD THE PREGLACIAL FLOOR, FOR NEITHER WISCONSIN NOR SPOKANE GOT FARTHER DOWN THE VALLEYS, YET THE WISC. V.T. FILLING IS VERY DEEP IN FRONT OF THE MORaine. THE KNOBS MUST BE REMNANTS OF A PREGLACIAL MID-VALLEY HILL.

ROCK KNOBS OR HILLS IN MID-VALLEY A FEW MILES NORTH OF SAND POINT MUST BE OF THE SAME ORIGIN. SEE WHAT DAVIS SAYS ABOUT THEM.

GLACIAL DEEPENING IN MOYIE RIVER VALLEY IS DIFFICULT TO RECOGNIZE. VALLEY SLOPES IN GENERAL ARE FAIRLY UNIFORM FROM TOP TO BOTTOM, THO NEAR MOYIE THE STEEPING FOR THE LOWER 200-300 FEET MAY BE RECOGNIZED. NO HANGING VALLEYS TO BE SEEN WHERE THIS STEEPING EXISTS AND IT THEREFORE SEEMS BETTER TO ATTRIBUTE IT TO WIDENING INSTEAD OF DEEPENING.

MOYIE TO KOOTENAY NATIONAL PARK

AUG. 22 1926

HEADWATERS OF MOYIE RIVER, SO FAR AS SEEN FROM HIWAY, ARE EITHER HIGH ABOVE THE AVERAGE LEVEL OF VALLEY FLOORS OF SOUTHERN BRITISH COLUMBIA OR ARE ERODED IN A LOWER PART OF THE PLATEAU. SEE ALTITUDES OF STATIONS ON THE SPOKANE INTERNATIONAL RR. (CPR SYSTEM) FOR THIS. NO NOTABLE CLIMB OR DESCENT IN CROSSING TO THE ROCKY MT. TRENCH AT CRANBROOK. THIS TRENCH IS A SPLENDID INTERMONTANE VALLEY, WIDER EVEN THAN THE VALLEY BETWEEN PEND OREILLE LAKE AND SPOKANE. THE ALIGNMENT OF THE ROCKIES TO THE EAST OF THE TRENCH SEEMS IMPOSSIBLE TO EXPLAIN BY GLACIAL EROSION,

AND THE WESTERN WALL OF THE SELKIRKS, SEEN FROM A DISTANCE ONLY, SEEMS ALMOST AS STRAIGHT.

THE TRENCH WALLS ARE CLOSER TOGETHER NEAR THE LATITUDE OF PREMIER (?) LAKE THAN ANY OTHER PLACE, THO THE VALLEY IS WIDE EVEN HERE. ITS CAPACITY AT THE WATER PARTING BETWEEN THE KOOTENAY AND THE COLUMBIA DRAINAGE IS EQUAL TO THE AVERAGE, AND TAKEN WITH THE OTHER ITEMS JUST NOTED, SEEMS TO DEMAND A GRABEN ORIGIN FOR THE TRENCH.

SELKIRK SUMMITS AS FAR NORTH AS INVERNESS LOOK MUCH LIKE SUMMITS OF THE INTERIOR PLATEAU. BUT FARTHER NORTH, ALPINE SUMMITS APPEAR, LIKE THOSE IN THE ROCKIES FROM THE HUGHES RANGE NORTH. APPARENTLY THESE ALPINE SUMMITS REACHED ABOVE THE CORDILLERAN ICESHEET.

LOWER SLOPES OF THE ROCKY MT FRONT APPEAR RUBBED BY TRANSVERSE MOVEMENT OF GLACIAL ICE LIKE ALL SLOPES IN THE VICINITY OF MOYIE LAKE, THE FORKS OF GRANBY RIVER AND MANY OTHER PLACES IN THE PLATEAU. BUT THE UPPER SLOPES VERY CLEARLY WERE NOT TOUCHED.

THE ROCKY MT. TRENCH APPEARS TO HAVE A GOOD SIZED HORST IN MID-WIDTH NEAR ATHOLMERE, AND IN SEVERAL PLACES ALONG THE ROCKY MT. FRONT, THE FAULTING APPARENTLY WAS DISTRIBUTIVE AND THE EDGES OF LARGE SLICES CONSTITUTE SHORT, SUBPARALLEL FOOTHILL RANGES.

ROCKY MT. TRENCH CONTAINS GREAT DRIFT DEPOSITS, WELL SORTED GRAVEL PREDOMINATELY THO TILL IS COMMON AND THERE ARE SILT TERRACES ABOUT COLUMBIA LAKE. THESE DEPOSITS DO NOT EXTEND UP THE MT. SLOPES AS A VENEER OR TERRACED DRIFT; THEY ARE MASSED IN A FEW BULKY TERRACES A FEW 100 FT. AT THE MOST ABOVE THE VALLEY BOTTOM. NEVERTHELESS, THE SURFACE OF THE GRAVEL TERRACES ABOVE THE LOWERMOST ARE TYPICALLY KAME AND KETTLE. WHERE THEY MARGIN SUCH VALLEYS AS COLUMBIA LAKE AND CANAL FLAT, THRU WHICH NO POST-GLACIAL STREAM HAS FLOWED, THERE IS NO ADEQUATE EXPLANATION FOR THEM OTHER THAN THE ONE APPLIED TO SIMILAR SITUATIONS THRUOUT NORTHERN WASHINGTON AND SOUTHERN BRITISH COLUMBIA

THE SILT TERRACES, LATER THAN THE GRAVEL AND TILL, ARE SIMILARLY EMPHATIC IN THEIR TESTIMONY. ICE CERTAINLY LAY IN MID-VALLEY AND DETERMINED LATERAL DRAINAGE AND LATERAL PONDING WHICH GAVE RISE TO THE GRAVEL AND SILT. THE SITUATION IS ALMOST IDENTICAL WITH THAT AT OKANOGAN LAKE. THE SILT TERRACES ARE LOWER THAN THE KAME AND KETTLE GRAVEL TERRACES. THE SILT ITSELF MORE COMMONLY CONTAINS INTERBEDDED GRAVEL. SOME EXPOSURES OF TILL SHOW SILT POCKETS OR LENSES FROM 10 TO 20 FEET THICK.

SILT TERRACES AT THE JCT OF BANFF AND GOLDEN ROADS ARE NOT MUCH MORE THAN 300 FEET ABOVE VALLEY FLOOR. GET CPR STATION ALTITUDES AND CHECK THESE WITH OR AGAINST DAWSON'S AND PARDEE'S CONCEPTION OF THE CONDITIONS OF SILT DEPOSITION.

NO NOTCHES OR SIDE-HILL GASHES SEEN IN ALL THE TRAVERSE OF THE ALPINE ROCKIES. NOR ROCK KNOBS SUCH AS THOSE ASCRIBED TO GLACIAL PLUCKING IN THE PLATEAU. VALLEYS ARE CLEAN, OPEN, CONFLUENT, WITH APPRECIABLE GRADIENTS. HANGING VALLEYS OF GOOD TYPICAL DEVELOPMENT, U-SHAPED LIKE THE MAINS. IT IS OBVIOUS THAT ICESHEET GLACIATION OVER A MOUNTAINOUS TRACT PRODUCES TOPOGRAPHIC RESULTS UNLIKE THOSE RESULTING FROM VALLEY GLACIERS. NO ONE HAS EVER MADE AN ADEQUATE STUDY OF THIS PROBLEM, SO FAR AS I AM AWARE.

NO KAME TERRACE DEPOSITS SEEN IN THE ALPINE TRACT ACROSS KOOTENAY AND RKY MTN PARKS. WERE CONDITIONS OF MELTING UNFAVORABLE OR ARE THEY LACKING BECAUSE THESE VALLEYS HAD GOOD LONGITUDINAL GRADIENTS SO THAT THE REQUISITE PONDING DID NOT OCCUR?