BROWNS BUTTE AND LATAH CREEK SPOKANE CO. JULY 20 1923

BROWNS BUTTE IS A QTZITE HILL PROJECTING THRU THE BASALT. A FEW LEDGES PROJECT THRU THE SOIL BUT IT IS LARGELY MANTLED WITH SOIL. NOT A PALOUSE HILL. ON SUMMIT OF SADDLE EAST OF FARM HOUSE ON WEST SLOPE IS A GRANITE PORPHYRY BLDR AND TWO BASALT BLDRS. BUT NO OTHER TRACE OF GLACIAL DRIFT SEEN, THO NO EXTENSIVE EXAMINATION WAS MADE. THESE ERRATICS ABOVE 2500, BELOW 2600.

GRAVEL PIT ON INLAND EMPIRE HIWAY AT NORTH BASE OF THE BUTTE, ALTL. ABT2400, IS IN AN UNUSUAL DEPOSIT OF ANGULAR QTZITE DEBRIS, MOSTLY PEBBLE SIZE, WHOLLY UNWORN, POORLY SORTED BUT STRATIFIED, WITH SOME FORESET BEDS DIPPING UP LATAH CREEK VALLEY. IN THE GRAVEL ARE GRANITE, GABBRO, BASALT AND PORPHYRITE IN COBBLES OR SMALL BLDRS. ALSO A FEW WELL WORN QTZITE PEBBLES. THIS DEPOSIT PROBABLY DUE TO GLACIAL WATERS MOVING SOUTHWARD. MATERIAL LARGELY FROM NORTH BLANK OF BROWNS BUTTE BUT SOME GLACIAL DEBRIS CONTRIBUTED. ALTITUDE OF TOP OF DEPOSIT IS BETWEEN 2300 AND 2400. ONE WELL-STRIATED BLDR.

IN LATAH CREEK VALLEY ABOUT A MILE SOUTH OF PARENTAL SCHOOL, ROADSIDE SECTION SHOW A BROWN STAINED TILL, WELL DOWN AT BOTTOM OF VALLEY UNDER STRATIFIED SILT, SAND AND FINE GRAVEL FROM APPEARANCE OF THE VALLEY IN THIS REGION, IT PROBABLY HAS BEEN FILLED ABOUT HALFWAY UP TO CREST OF BASALT BLUFFS WITH GLACIAL AND FLUVIOGLACIAL WASTE. DEGREE OF DISSECTION MUCH GREATER THAN THE LIDGERWOOD TERRACE GRAVELS.

PARADISE PRAIRIE

THIS TRACT, BETWEEN NPRR ON WEST AND LATAH CREEK ON EAST BEARS SCATTERED GRANITES AND SOME GLACIAL GRAVEL DEPOSITS. BUT NO TRUE TILL SEEN AND NO MORAINIC TOPOGRAPHY. BASALT CLOSE TO SURFACE BUT A GOOD SOIL COVERS MOST OF IT. ONE LOW KNOB OF QTZITE. TOPOGRAPHY OF BASALT SHOWS INDISTINCT CHANNELS IN PLACES BUT NOT OF NOTEWORTHY DEPTHS. MOST OF THE PRAIRIE IS IRREGULARLY UNDULATING. LITTLE IN THE WAY OF FLATS AND BLUFFS TO EXPRESS THE FLOW STRUCTURE OF THE BASALT. NO SCABLAND.! MOST PRONOUNCED BLUFFS AND ABANDONED CHANNEL SEEN ON TRAVERSE FROM BROWNS BUTTE TO MARSHALL IS ABOUT A MILE WEST OF THE BUTTE. THE LARGEST ERRATICS SEEN ARE BETWEEN THE BUTTE AND THIS CHANNEL, ABOUT 2400 AT.T THEY ARE GRANITES, LITTLE AFFECTED BY WEATHERING.

PARADISE PRAIRIE, LIKE SUNSET, FIVE-MILE, ETC./ BEARS A GROUND MORAINE SOIL APPARENTLY, AND WAS LITTLE AFFECTED BY ESCAPING GLACIAL WATERS. HENCE ABSENCE OF SCABLAND.

BUT WHY NOT AFFECTED WHEN ICE WAS ADVANCING TO THIS AREA AND RETREATING FROM IT??? APPARENTLY THE TIME DURING WHICH THE ICE STOOD AT ITS MAXIMUM WAS MUCH GREATER THAN THE TIME CONSUMED DURING ADVANCE AND RETREAT OVER THIS TRACT.

MARSHALL TO SONSER SCHOOL JULY 20 1923

AT MARSHALL IS A DELTA FRONT, OPENED BY A GRAVEL PIT IN THE WEST WALL OF LAKE CREEK VALLEY. THE MATERIAL IS MOSTLY A FINE BASALT GRAVEL (SOME FOREIGN MATERIAL) WITH BEAUTIFUL FORESET BEDDING. DIP ABOUT 23°. SLOPE OF FRONT 20°. BEDDING PARALLELS THE SLOPE AND APPARENTLY DETERMINES IT. TOP OF DELTA IS NOT LEVEL BUT RISES TO NW. SLOPE 3°. NOT A LARGE DELTA BUT CLEARLY PRODUCED BY GLACIAL WATERS FROM THE NORTHWEST. NO GOOD CHANNEL SEEN ON THE UPLAND HOWEVER. ALTITUDE OF BRINK NOT SECURED. MUST BE GOTTEN ! SHOULD BE THE SAME AS FLOOR

OF COL IN NORTH PINE CREEK SPILLWAY. DELTA PROBABLY BUILT DURING WANING STAGES OF SPOKANE GLACIATION. IF DURING ADVANCE TO SPANGLE, IT PROBABLY WOULD HAVE BEEN OBLITERATED OR GREATLY MODIFIED. ALSO WOULD HAVE A BRINK (IF NOT DESTROYED) AT ALTITUDE OF NORTH PINE CREEK COL AT BEGINNING OF ITS OPERATION AS SPILLWAY. ALTITUDE WILL SETTLE THIS.

A LARGE GRANITE ERRATIC ON THE 3° SLOPE, NOT FAR FROM BRINK.

PLAIN BETWEEN MARSHALL AND THE HILLS NORTH OF CHENEY IS DETERMINED BY THE UPPER SURFACE OF THE BASALT. NO TRACE OF HIGHER LEDGES ON FLANKS OF THESE HILLS. PLAIN BEARS MORE SOIL THAN PARADISE PRAIRIE (BUT A POORER SOIL); AT LEAST THERE ARE VIRTUALLY NO BASALT OUTCROPS. NO SUGGESTION OF CHANNELS. APPARENTLY NEVER A ROUTE OF ESCAPING ~~GLACIAL~~ ERODING GLACIAL WATERS. VARIOUS KINDS OF ~~GLACIAL~~ GRANITOIDS ALL OVER IT, BUT NOT ABUNDANT. TOPOGRAPHICALLY IT IS A SE EXTENSION OF SUNSET PRAIRIE.

HILL NORTH OF BONSER SCHOOL IS GRANITE. ITS SOIL FULL OF FINE, ANGULAR GRANITE DEBRIS. NOT A BASALT, QTZITE OR OTHER KIND OF ROCK FOUND ON IT. APPARENTLY NEVER COVERED BY GLACIAL ICE, AT LEAST SPOKANE ICE. NO LEDGES OF GRANITE EXCEPT AT NORTH BASE WHERE ICE PROBABLY RUBBED OFF THE RESIDUAL SOIL. THIS SOIL COVERING THE HILL COULD NOT HAVE REMAINED IF ICE HAD PASSED OVER IT, AND COULD HARDLY HAVE FORMED SUBSEQUENT TO THE SPOKANE GLACIATION. A FEW RATHER SHARP KNOBS ON SUMMIT, WHICH ICE WOULD HAVE RUBBED OFF, OR RUBBED BARE AT LEAST.

YET A COMPARISON OF THE RESIDUAL SOIL ON THE GRANITE HILLS AT MICA WITH THAT ON THE BONSER HILL IS INSTRUCTIVE. DECOMPOSITION HAS DESTROYED ALL ORIGINAL SILICATES AT MICA. ONLY THE CHALKING OF FLDSPRS HAS OCCURRED AT BONSER HILL. EITHER THE GRANITE IS QUITE DIFFERENT IN CHARACTER OR THE BONSER HILL HAS BEEN RUBBED OFF BY GLACIAL ICE. THE FIRST SUGGESTION IS OF LITTLE VALUE FOR IT IS A MATTER OF FELDSPAR DECOMPOSITION, NOT GRANITIC DISINTEGRATION, WHICH MAKES THE DIFFERENCE IN MANTLE ROCK.

MOST SATISFACTORY EXPLANATION NOW SEEMS TO BE THAT GLACIAL ICE HAS BEEN OVER THIS HILL. BUT NO ERRATICS REMAIN TO TELL THE STORY, WHILE THEY ARE FREQUENTLY FOUND OVER THE PLAIN TO THE WEST, NORTH AND EAST. AND THE GRANITE HAS CRUMBLED TO A MANTLE WHILE NO GRANITE ERRATICS ARE SO ALTERED. THE GLACIAL ICE, THEREFORE, WAS THE CHENEY ICESHEET, WHICH IS BELIEVED AT PRESENT TO BE OLDER THAN THE PALOUSE HILLS TOPOGRAPHY, WHICH IN TURN IS OLDER THAN THE SPOKANE GLACIATION.

A PIT OPENED ON BASE OF SOUTHWEST SIDE OF THIS HILL, NEAR MEADOW LAKE–MARSHALL ROAD, EXPOSES POORLY SORTED, VERY LITTLE WORN, STRATIFIED GRANITIC DEBRIS, WITH PLENTY OF BASALT, GRANITE, QUARTZITE, ETC. THE GRANITIC MATERIAL IS A GRAVEL IN TEXURE BUT WHOLLY ANGULAR, IDENTICAL WITH THAT ON THE SLOPES TODAY. SINCE THE DEPOSIT WAS MADE BY SPOKANE WATERS, THE HILL THEN BORE A MANTLE LIKE IT DOES TODAY, FROM WHICH THIS DEBRIS WAS DERIVED. ONLY THE BASAL PORTION OF THE HILL WAS REACHED, HENCE BARE LEDGES OF GRANITE EXIST ONLY THERE AND THE REMAINDER OF THE HILL IS STILL MANTLED.

COEUR D'ALENE MINING DISTRICT.

LEITH REMARKED TO RUSH WHITE, A LOCAL MINING MAN, THAT THE REGION'S GEOLOGY WAS JUST WHAT THE LAKE SUPERIOR DISTRICT WAS, BEFORE IT WAS ALL ERODED AWAY.

OSBORNE FAULT NOW CONSIDERED BY MANY, INCLUDING UMPLEBY, TO HAVE A HEAVE OF 10–15 MILES ALONG THE STRIKE. DIP IS ABOUT 60° AVERAGE. SAID TO HAVE BEEN TRACED EASTWARD INTO MONTANA AND TO HAVE A TOTAL LENGTH OF 100 MILES.

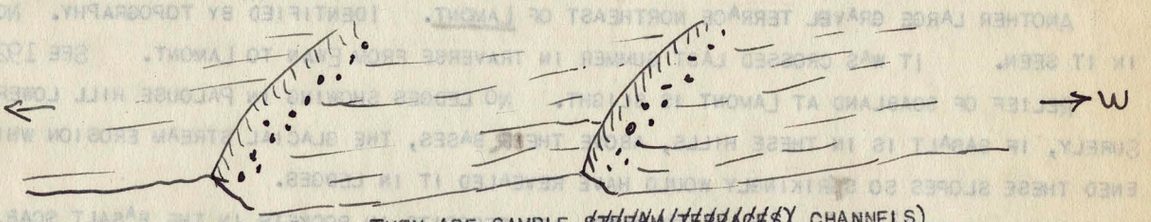
UMPLEBY SAYS THAT CHARACTER OF FORMATION BEARS NO RELATION TO OCCURRENCE OF ORE BODIES. THAT A SHALE IS AS LIKELY AS A QTZITE TO OCCURRENCE OF ORE BODIES. (BULL. 732)

TERM "QTZITE" APPLIED BY LOCAL MEN TO ALL SILICEOUS SEDIMENT, EVEN THO AS FRANGIBLE AS SLATE AND NEARLY AS WELL CLEAVED, AND EVEN THO A SMEAR OF SERICITE OR CLAY. MORNING MINE SHAFTS, DRIFTS AND STOPES SHOW PRE-CAMBRIAN STRUCTURES VERY POORLY INDEED. BUT OPPOSITE O-W STATION AT WALLACE, AND ON HIGHWAY EAST, IS AN EXPOSURE WHICH MIGHT HAVE BEEN PICKED UP BODILY FROM THE LAKE SUPERIOR REGION OR THE CLAYEY PHASES OF THE BARABOO FORMATION. OTHERS UP THE CANYON TOWARD BURKE.

BETWEEN SPOKANE AND THE COEUR D'ALENE MINING DISTRICT.

WISCONSIN OUTWASH VALLEY TRAIN EXTENDS UP SPOKANE VALLEY TO POST FALLS, IDAHO. HERE THE SPOKANE RIVER ENTERS FROM A MUCH SMALLER VALLEY. THE V.T. ABOVE POST FALLS (RATHDRUM PRAIRIE) BEARS NO STREAM, THO IT OCCUPIES A LARGE VALLEY.

THE V.T. TERRACED. ONE TERRACE AT OR NEAR POST FALLS, AT THE INNER ANGLE BETWEEN RATHDRUM PRAIRIE VALLEY AND SPOKANE RIVER VALLEY, IS MORE THAN 100 FT ABOVE THE GENERAL LEVEL. OTHER TERRACES ALONG FLANKS, PERHAPS 50 FT ABOVE GENERAL LEVEL. THEN OTHER TERRACES, OF A DIFFERENT CHARACTER. THEY ARE DIAGONALLY TRANSVERSE TO THE LENGTH OF THE VALLEY AND SLIGHTLY CURVED WITH CONVEXITY UPSTREAM. SEEN ONLY FROM AN AUTO. GENERAL RELATIONS SEEMS TO BE AS FOLLOWS.



(LATER NOTE— ABOVE IS IN ERROR. THEY ARE SIMPLE ~~STREAM TERRACES~~ CHANNELS)

CONTACT OF SCARP WITH VALLEY WALLS IS FARTHER DOWN STREAM ON SOUTH SIDE. STEEP SLOPE FACES WEST, GENTLE SLOPE EAST IN SOME PLACES A GREAT NUMBER OF BOULDERS AT FOOT OF SCARP AND ON LOWER PART OF GENTLE SLOPE. HT. 30-50 FT. IF THESE TERRACES ARE CHANNEL RECORDS, IT IS CURIOUS THAT THEIR ORIENTATIONS SHOULD SO NEARLY CONFORM. IF THEY WERE SMALLER, THEY WOULD DO VERY WELL FOR CURRENT RIPPLES, MIGRATING DOWN STREAM. ARE THEY NOT THE GRAVEL BARS SEEN IN MANY STREAMS, WHICH CROSS THE CHANNEL DIAGONALLY, CAUSE RIPPLES IN LOW WATER, HAVE A STEEP DOWNSTREAM AND A GENTLE UPSTREAM SLOPE, AND HENCE DEEP WATER IMMEDIATELY DOWNSTREAM FROM THEM?
(LATER NOTE—— APPLIES TO THIS PARAGRAPH AS ABOVE—— SIMPLE CHANNELS)

BELT SERIES ALL THE WAY FROM CDALENE LAKE TO THE MINING DISTRICT. BUT ALONG NORTH SIDE OF LAKE, CUTS IN YELLOWSTONE TRAIL SHOW BASALT IN TWO PLACES, THO ARGILLITES OUTCROP ELSEWHERE IN ALL CUTS. NO CONTACT SEEN. BASALT IS COLUMNAR. COLUMNS DEFORMED !! MIGHT BE COLUMBIA LAVA. THE DEFORMATION MIGHT BE ONLY SLIDING, BUT LOOKS LIKE MT. FOLDING. RELATION TO STRUCTURE OF ARGILLITE NOT DETERMINED.

UP SPOKANE VALLEY, NO BASALT SEEN BEYOND A FEW MILES EAST OF SPOKANE CITY LIMITS. GENTLE SLOPES OF BOUNDING MTS. SHOULD CARRY LEDGES IF IT EVER HAD BEEN THERE.

(SEE NOTES OF AUG. 26)

TRAVERSE ON S.P. AND S. RR SPOKANE TO PASCO. OBSERVATION CAR PLATFORM GEOLOGY.

JULY 23 1923

BIG GRAVEL PITS AT FORT WRIGHT IN WISCONSIN V.T. ARE THE GRAVEL DEPOSITS ALONG NPRR ON EAST SIDE LATAH CREEK OF WISCONSIN OR SPOKANE AGE? (SPOKANE— LATER NOTE)

SCABLAND SOUTH OF CHENEY WITHOUT MUCH BARE ROCK. SOIL ON KNOBS AND DEPRESSIONS AND CHANNELS FILLED WITH PEAT AND SEDIMENT. LIKE THE COUNTRY BETWEEN BROWNS BUTTE AND MARSHALL. LITTLE RELIEF ALSO. BUT SOUTH OF AMBER, PLENTY OR BARE ROCK AND PLENTY OF CANYONS.

AT AMBER, PALOUSE HILLS UP CLOSE TO LAKE ON EAST. HILLS HAVE STEEP SLOPES TO SCABLANDS IN MOST PLACES AND GENTLE SLOPES IN INTERIOR OF THE GROUP. THIS IS TRUE ALSO IN PALOUSE HILLS WEST OF AMBER. THE LAKE HERE (CALVERT LAKE) IS MUCH ELONGATED WITH THE ELONGATION OF THE SCABLAND TRACT AND DOWN IN A ROCK-WALLED CANYON.

MANY ISOLATED GROUPS OF PALOUSE HILLS SEEN FROM TRAIN.

AT RODNA, LEDGES OF BASALT SEEN UP IN THE LOWER PART OF THE STEEPENED SLOPES OF PALOUSE HILLS TO THE EAST. SOUTH OF RODNA, JUST OVER INTO LINCOLN CO., THERE ARE LARGE GRAVEL PITS FOR RR BALLAST, ON BOTH SIDES OF THE TRACK. THE GRAVEL DEPOSIT IS BELOW THE LEVEL OF THE PALOUSE HILL BASES, AND AS SHOWN BY BASALT LEDGES WHICH DISAPPEAR UNDER IT, IT WAS DEPOSITED ON A SCABLAND FLOOR. TOPOGRAPHY HERE SHOWS A BROAD AREA OF GRAVEL TO SOUTHWEST OF FLAT-TOPT BASALT KNOBS. PROBABLY A BAR.

ANOTHER LARGE GRAVEL TERRACE NORTHEAST OF LAMONT. IDENTIFIED BY TOPOGRAPHY. NO OPENINGS IN IT SEEN. IT WAS CROSSED LAST SUMMER IN TRAVERSE FROM EWAN TO LAMONT. SEE 1922 NOTES.

RELIEF OF SCABLAND AT LAMONT IS SLIGHT. NO LEDGES SHOWING IN PALOUSE HILL LOWER SLOPES. SURELY, IF BASALT IS IN THESE HILLS, ABOVE THEIR BASES, THE GLACIAL STREAM EROSION WHICH STEEPENED THESE SLOPES SO STRIKINGLY WOULD HAVE REVEALED IT IN LEDGES.

ONE MILE SOUTH OF LAMONT, IN RR CUTS, ARE DEPOSITS IN POCKETS IN THE BASALT SCAB, WHICH LOOK LIKE TILL. MUCH STAINED. DO NOT LOOK LIKE SPOKANE DEPOSITS. (SEE AUG. 8 NOTES)

TRUNCATION OF PALOUSE HILL SLOPES MARGINING THE SCABLAND, EAST OF LAMONT, IS REMARKABLE FOR MILES.

AT MACALL, WEST OF RR, ARE VERY FLAT-TOPT DISSECTED PALOUSE HILLS. NOT AS HIGH AS AVERAGE ABOVE BASALT. VERY MARKED TRUNCATION. NO LEDGES. A LIGHT-COLORED MATERIAL SHOWS IN UNSODDED SLOPES.

THE MAIN ROCK LAKE SCABLAND CHANNEL JOINS LAMONT AREA A FEW MILES BELOW MACALL. GIVES A LONG, UNINTERRUPTED VIEW TO THE EAST, BACK INTO THE PALOUSE HILLS TOPOGRAPHY. STEEPENED, TRUNCATED SLOPES SHOW PLAINLY.

SOUTH OF LANTZ, ON BOTH SIDES OF RR., PALOUSE HILLS ARE FLAT-TOPT. SCABLAND AT LANTZ IS ABOUT 2 MILES WIDE. TRUNCATION IS PRONOUNCED. NO BASALT LEDGES IN SLOPES.

COARSE GLACIAL OR FLUVIO-GLACIAL DEBRIS, BETWEEN LANTZ AND BENGE, IN SITUATIONS LIKE THAT ONE MILE SOUTH OF LAMONT. GRAVEL PIT IN HILL AT BENGE, NORTH OF TOWN, WEST OF TRACK. HERE IS SOME GULLYING IN THE BASALT LEDGES OF THE SCABLANDS, BY DRAINAGE FROM THESE PALOUSE HILLS.

TALUS ON COW CREEK VALLEY WALLS IS 3/4 OR 4/5 TO THE TOP SOME LOOSE ROCKY TALUS BUT MOST IS GRASSED. LARGE GRAVEL BARS IN PLACES ON GENTLER SLOPES OF COW CREEK VALLEY AND ON SCABLAND IN WHICH THE VALLEY IS CUT. TERRACE TOPOGRPAHY OF SOME OF THESE DEPOSITS IS QUITE DEFINITE BUT QUITE UNLIKE THE SHARPLY CUT WISCONSIN TERRACE OF THE SPOKANE V.T. IF THESE ARE TRUE

BARS, SUBFLUVIAL IN ORIGIN, THEY PROBABLY NEVER HAD AS SHARP OUTLINES AS THE SPOKANE V.T. TERRACES THEY WERE CONSTRUCTIONAL, NOT EROSIONAL IN ORIGIN, AND PROBABLY ORIGINALLY HAD ROUNDED EDGES. THE SMALL RAINFALL AND POROSITY OF THE GRAVEL PROBABLY EXPLAINS THE RELATIVE PAUCITY OF GULLYING.

TO EAST OF HOOPER (SP AND S. STATION) THE SKYLINE IS SCABLAND FOR MILES. NO PALOUSE HILLS NEARER THAN 10-15 MILES IN THAT DIRECTION.

NORTH OF WASHTUCNA COULEE HEAD, A LARGE GRAVEL BAR CAPS THE BRINK. AT CROSSING OF SP&S AND O-W IN THE COULEE, PALOUSE HILLS ABOOT THREE MILES TO THE NORTH.

AT WASHTUCNA STATION, NORTH WALLS OF COULEE SHOW LITTLE ROCK, DUE TO GRAVEL MANTLE. A BIG GRAVEL HILL SOUTH OF STATION HERE, SOUTH SIDE OF COULEE. REACHES FROM FLOOR ALMOST TO SUMMIT OF BLUFFS. MUST HAVE BEEN COMPLETELY FILLED ACROSS FROM N TO S AT ONE TIME (SEE AUG. 19 NOTES)

LOOKING EAST UP THE COULEE FROM WASHTUCNA, PALOUSE HILLS SEEN IN AREA BETWEEN COULEE AND PALOUSE RIVER.

GRAVEL COVERS OR CONSTITUTES THE BLUFFS ON THE NORTH IN PLACES WEST OF WASHTUCNA. PALOUSE HILLS NOT FAR BACK FROM EDGE OF COULEE THRUOUT ITS LENGTH. THIS COULEE IS NOT CUT IN A WIDE SCABLAND, AS IS COW CREEK VALLEY.

FROM HEAD OF COULEE TO KAHLOTUS, NO ROCK ON FLOOR EXCEPT ONE SMALL ROCK ISLAND IN WASHTUCNA LAKE. AT KAHLOTUS, RR CUT IN LACUSTRINE SEDIMENTS, 30 FT OR SO ABOVE THE LAKE LEVEL.

DEVILS CANYON IS A WILD, SPECTACULAR GORGE, VERY NARROW, AND TALUS SLOPES FROM OPPOSITE SIDES OVERLAP IN PLACES. THE TALUS IS OF SPOKANE AGE, OR OLDER. NO STREAM, ALMOST NO TRIBUTARY GULCHES. NO GRAVEL SEEN. DEPTH AT COL 450 FEET. LAKE SURFACE 15-20 FT LOWER THAN COL. (MUCH MORE DIFF. IN ALTITUDE THAN THIS) MOUTH 200 FT OR MORE ABOVE SNAKE RIVER. GRAVEL TERRACE HERE. MAY BE A DELTA.

LOWER PART OF SNAKE RIVER BLUFFS WITH MUCH BARE ROCK. IN GENERAL ITS TALUS IS OF SPOKANE AGE OR OLDER. UPPER PART OF BLUFFS (UPPER 2/3) IS MUCH OLDER. LOOKS LIKE PALOUSE TOPOGRAPHY BACK FROM BLUFFS ON SOUTH, BUT NOT MUCH RELIEF TO IT.

ROCK BOTTOM TO SNAKE VALLEY AT MONOMENTAL RAPIDS.

HUGE GRAVEL BANKS ALONG BOTH SIDES OF SNAKE EAST OF BEND NEAR JONES SCHOOL, 2-3 MILES EAST OF SNAKE RIVER JCT. GRAVEL 3/4 TO 4/5 AS HIGH AS ROCK BLUFFS. FRESH, BRIGHT GREY, NO CONSOLIDATION. RIVER GRAVEL, NOT TALUS. FROM HERE DOWN, GRAVEL IN HIGH BANKS AT MANY PLACES. NO BASALT ABOVE RIVER LEVEL FROM LEVY TO PASCO.

ORTLEY ANTICLINE WEST OF FALLBRIDGE.

CRUSHED ZONE IN STEEP SOUTHERN SIDE SHOWS IN OLD S.P. AND S. CUT A MILE WEST OF AVERY. REMARKABLY BRECCIATED. MANY SLICKENSIDED SURFACES, VARIOUSLY ORIENTED. COLUMNAR AND FLOW STRUCTURE OBLITERATED. CREST OF KLICKITAT OR COLUMBIA MTN. IS NORTH OF THE CRUSHED ZONE RETREAT OF THE CLIFFS HAS CAUSED THIS. HERE THEREFORE THE TOPOGRAPHIC FORM ISNT EXACTLY COINCIDENT WITH THE STRUCTURAL FORM.

SOURCE OF PALOUSE DUST STORMS.

DUST BLOWS OFF TOP OF HILL SOUTH OF WALLULA GATEWAY IN GREAT CLOUDS WHICH HANG IN AIR LIKE SMOKE FOR SEVERAL MIEES. THIS DUST IS OBTAINED FROM THE SUMMER FALLOWED WHEAT FIELDS. ON WASHINGTON SIDE, NO DUST CLOUDS ARE PRODUCED. THIS SIDE NOT CULTIVATED OVER THE SUMMIT.

IN QUINCY VALLEY, HEAVY DUST CLOUDS WERE TRACEABLE UPWIND TO SUMMER FALLOW. SAME AT WARDEN.

I SUSPECT THAT DUST STORMS WERE OF LITTLE CONSEQUENCE BEFORE CULTIVATION BEGAN.

WALLULA TO HERMISTON JULY 24

WALLULA GATEWAY. THE ABANDONED CHANNELS WHICH SEPARATE THE ROCK HILLS OF THE GROUP BETWEEN THE ROAD AND THE RR ON EAST SIDE OF GATEWAY CONTAIN NO GRAVEL. THE TALUS SLOPES ARE DEFINITELY AS OLD AS SPOKANE. LOWEST CHANNEL IS 200 FT ABOVE THE RIVER SURFACE, 500 FT A.T. THUS THE COLUMBIA WATERS SINCE THE SPOKANE EPOCH HAVE NEVER FLOWED 200 FT HIGHER THAN THEY DO TODAY. NO GRAVEL FILL HAS EVER RAISED THE RIVER LEVEL THAT MUCH HERE.

THE ABOVE CONCLUSION SEEMS UNESCAPEABLE IF THE TALUS IS SPOKANE. YET AT THE MOUTH OF JUNIPER CANYON IS A FRAGMENT OF A TERRACE, COMPOSED LARGELY OF LOCAL BASALT, SUBANGULAR, BUT ALSO CONTAINING SOME GRANITE COBBLES. THIS TERRACE SHOULD BE A PORTLAND DELTA AFFAIR. ITS UPPER SURFACE IS 450 FT. A.T., ONLY 50 FEET BELOW THE FLOOR OF THE LOWEST CHANNEL ABOVE NOTED, AND SOME SEVEN OR EIGHT MILES FARTHER DOWN STREAM.

AND STILL MORE PUZZLING IS THE PRESENCE OF SOME TALUS, REACHING THE FLOOR OF THE COLUMBIA VALLEY IN THE GATEWAY, AND 2/3 TO 3/4 THE HEIGHT OF THE CLIFF. IT SHOULD BE SPOKANE IN AGE. BUT IT MUST BE YOUNGER THAN THE PORTLAND DELTA GRAVEL FILL, ELSE IN THE REMOVAL OF THAT FILL, THE TALUS DEBRIS WOUDD GO ALSO. (JUNIPER CANYON HAS THE ONLY GRAVEL TERRACE IN THE GATEWAY)

IS SOMETHING WRONG WITH THE CRITERION OF TALUS HEIGHT ON WALLS? OR IS THE PORTLAND DELTA OLDER THAN PREVIOUSLY THOT? OR ARE THE PORTLAND DELTA FRAGMENTS BARS INSTEAD OF TERRACES, AS PREVIOUSLY THOT?

AGE OF THE GRAVEL AT COLD SPRINGS RESERVOIR DAM STILL IN DOUBT. TRAVERSE MADE FROM JUNIPER CANYON TO THE RESERVOIR TO SEE IF THIS GRAVEL OCCURRED ON HIGHER SLOPES OF THE FOLD. BUT THESE SLOPES ARE UNIVERSALLY MANTLED WITH LOESS AND SAND. NOT A LEDGE OF BASALT IN SIGHT FROM THE COLUMBIA TO THE RESERVOIR. ON THE SURFACE OF THIS AEOLIAN DEPOSIT, UP TO 1200 AT ANY RATE, THERE ARE SCATTERED FRAGMENTS OF GRANITE, SCHIST, DIORITES, QUARTZITE, ETC. THESE, WHERE LARGE AND ANGULAR AND IN "NESTS", ARE ASCRIBED TO THE LATE PLEISTOCENE SUBMERGENCE AND ITS FLOATING ICE. BUT NONE OF THIS CATEGORY FOUND ABOVE 1014 AT.T

AT HIGHER AND LOWER LEVELS WERE FOUND SMOOTH, WORN RIVER PEBBLES OF QTZITE AND OTHER FOREIGN MATERIALS. THEY OCCUR ALONG TWO OR THREE ROADS WHICH WERE FOLLOWED IN PART, BUT THEY WERE NOT FOUND ON ADJACENT AREAS ALONGSIDE THE ROAD. THIS SEEMS TO MEAN THAT GRAVEL HAS BEEN HAULED OVER THE ROADS, THO THE COUNTRY IS ONLY A WINTER SHEEP GRAZING GROUND AND THE ROADS ARE MERE PATHS THRU THE SAGE. STILL, THE GRAVEL MAY HAVE COME FROM THE RIVER AND GONE TO THE WHEAT COUNTRY 10 MILES OR SO FARTHER SOUTH.

WHERE RIVER PEBBLES LIE AT LOWER LEVELS, THEY OCCUR SCATTERED PRETTY WELL OVER THE AREA, ESPECIALLY BELOW ABOUT 900 FT A.T. BUT SO NUMEROUS IS THE ERRATIC MATRERIAL ALSO BELOW THIS ALTITUDE THAT THE TWO KINDS OF SCATTERED DEBRIS MAY HAVE COME FROM THE SAME FLOATING ICE.

ON THE OTHER HAND, SUCH RIVER PEBBLES MAY MEAN THE PRESENCE OF THE GRAVEL FORMATION EXPOSED AT THE RESERVOIR DAM; BURIED BENEATH THE LOESS AND SAND. THERE ISNT A SCAR OR GULLY IN THE REGION, BY WHICH TO ATTEMPT TO ANSWER THIS QUESTION.

AND ALONG THE SHORES OF THE RESERVOIR, WAVES HAVE CUT CLIFFS 6-8 FT HIGH IN THE LOESS AND SAND WITHOUT REVEALING A SINGLE FOREIGN PEBBLE IN THE EOLIAN MATERIAL OR WASHED OUT OF IT. THE LOESS APPEARS TO BE OLDER THAN THE SCATTERED GRAVEL, HOWEVER IT MAY HAVE COME THERE. AND FROM THE WAY THESE WISCONSIN ERRATIC PEBBLES STILL LIE ON THE SURFACE, THERE HAS BEEN VERY LITTLE LOESSIAL ACCUMULATION SINCE THEN.

PROBABLY MOST OF THE HERMISTON IRRIGATED DISTRICT IS UNDERLAIN BY THE GRAVEL—— BUT THERE ARE NO SURFACE SIGNS OF IT. THE DUST MANTLES EVERYTHING.

THE BEST ARGUMENT FOR THE PORTLAND DELTA AGE OF THE COLD SPRING RESERVOIR GRAVDL IS THE TOPOGRAPHY. HERE ARE OLD CHANNELS AS ON THE PORTLAND DELTA ITSELF AND ON THE ARLINGTON DELTA. NO DISSECTION AS IN THE DALLES FORMATION BACK OF THE DALLES, OR AS IN THE SATSOP FORMATION IN MANY, MANY PLACES.

YET THE POSITIVE STATEMENT CANNOT BE MADE. THE AGE RELATIONS OF THIS GRAVEL ARE STILL IN DOUBT.

A CANYONED COULEE WITH SURROUNDING SCABLAND ISNT NECESSARILY CUT INTO THE SCABLAND. IT MAY BE A PRE-SCABLAND VALLEY WHICH FILLED TO BRIMMING AND SPILLED OVER, THE SCABLAND BEING YOUNGER THEN THE COULEE.

PASCO TO CONNELL JULY 25 1923

GRAVEL TERRACES NORTH OF PASCO TO ABOUT 650 CONTOUR. AN ESPECIALLY PROMINENT ONE ABOUT 500 ON BRINK. FIRST BASALT EXPOSURE EAST OF JACKASS MTN. (ITSELF PRESUMABLY BASALT UPFOLD) SCABLAND CANYONED TOPOGRAPHY OF VALLEY WALLS IMMEDIATELY NORTH OF ELTOPIA. SPOKANE TALUS. LARGE GRAVEL BLUFF HERE ALSO.

ESQUATZEL COULEE A FEW MILES NORTH OF ELTOPIA LOSES ITS BASALT WALLS ON THE WEST. ALL GRAVEL COVERED. MUCH GRAVEL ON THE FLOOR. NO ROCK FLOOR SHOWN.

BASALT AGAIN MUCH IN EVIDENCE AT MESA THO THERE IS ALSO A GOOD DEAL OF GENTLY SLOPED GRAVEL-COVERED TOPOGRAPHY IN THE BOUNDING WALLS, THE GRAVEL APPARENTLY COMING OVER INTO THE COULEE FROM THE NORTH.

LARGE GRAVEL TERRACE DOWN IN COULEE WEST OF TRACK 2 MILES ABOVE MESA. ALTITUDE ABOUT HALF THE HEIGHT OF THE BLUFFS. RR GRAVEL PIT IN IT. THIS ON CONNELL MAP. GOOD CANYON TOPOGRAPHY FROM HERE ALMOST TO CONNELL.

AT CONNELL IS A BROADENED PORTION OF THE VALLEY, WHERE WASHTUCNA JOINS ESQUATZEL COULEE. IN IT ARE EXTENSIVE GRAVEL DEPOSITS. THE HIGHEST TERRACE LIES ALONG THE NORTH SIDE, BOTH EAST AND WEST OF TOWN. ALTITUDE OF MARGIN WEST OF TOWN IS ABOUT 1000 FT. A.T. TERRACE COMPOSED OF BASALTIC SAND AND FINE GRAVEL.

NORTH OF IT IS THE SCARP OF THE PARADISE FLATS, THE BRINK OF WHICH IS 1100 A.T. AND THE SURFACE FOR 15 SQ. MI. OR SO LYING BETWEEN 1100 AND 1150. A GENTLE RISE TO THE NORTH. THE FLATS SHOW NO SUGGESTION OF DISSECTION, SAVE FOR MINOR GULLIES ON THE MARGINS. ONLY ONE IS MORE THAN 1/2 MILE LONG; THIS IS THE STREAM VALLEY FOLLOWED IN PART BY CONNELL NORTHERN RR. ITS DRAINAGE COMES FROM HIGHER LANDS TO THE NORTH. TO THE NORTH, SOUTH AND EAST CAN BE SEEN THE SLIGHTLY HIGHER, MATURELY DISSECTED PALOUSE HILLS TOPOGRAPHY, CLEARLY MUCH OLDER.

A WELL 2 1/2 MILES WEST OF CONNELL, ON THE BRINK OF THE SCARP, PENETRATED 35 FT OF LIMESTONE GRAVEL, 100 FT OF YELLOW CLAY AND 100 FT OF DARK COLORED STICKY CLAY BEFORE FINDING THE BASALT.

THE LIMESTONE GRAVEL IS EXPOSED NEAR THE WELL IN A ROAD CUT. IT IS DENSE AND FIRM BUT RUBS LIKE CHALK AND IS PURE WHITE IN COLOR. SECONDARY DEPOSITION HAS PARTIALLY INDURATED IT AND GROWTH OF FRAGMENTS WITH TUFACEOUS SECRETIONS, PARTICULARLY ON THEIR LOWER SIDES, IN PART OBLITERATES THE APPEARANCE OF A GRAVEL CONGLOMERATE. BUT IT IS SUCH. PLENTY OF ROUNDED

PEBBLES CAN BE COLLECTED. REPORTED THAT BY ANALYSIS, THE DEPOSIT IS 96% CACO3

THE SCARP APPARENTLY WAS PRODUCED WHEN THE SCABLAND TO THE SOUTH AND WEST WERE ERODED. THEIR TALUS IS SPOKANE. THEY MAKE A RESPECTABLE SCABLAND ASSEMBLAGE ABOUT THREE MILES SW OF CONNELL WHERE THEY DESCEND FROM THE SURFACE OF THE BASALT TO THE FDOOR OF ESQUATZEL COULEE. ESQUATZEL-WASHTUCNA IS OLDER THAN THE SCABLANDS. PARADISE FLATS PROBABLY IS UNDERLAIN BY THE RINGOLD FORMATION.

THE PARADISE FLATS BEAR THE DRIFTED ERRATICS. A GRANITE BLDR, 2X2X4, WAS UNCOVERED IN PLOWING NEAR THE WELL ABOVE NOTED (abt. 1100) ROUNDED QTZITE PEBBLES AND ANGULAR GRANITE FRAGMENTS SEEN. ONE DENSE LIMESTONE PEBBLE, NOT LIKE THE LIMESTONE OF THE CONGLOMERATE, WITH GLACIAL STRIAE. Err.

SECTIONS OF THE PARADISE FLATS DEPOSIT ALONG CONNELL NORTHERN RR, 3 TO 4 MILES OUT OF CONNELL BEDDING AND COMPOSITION INDICATED A FLOODPLAIN DEPOSIT. CHIEFLY SILT AND SAND, A FEW THIN STRATA OF GRAVEL. NONE OF THE LIMESTONE CONGLOMERATE. PEBBLES REPRESENT A VARIETY OF ROCKS AND INDICATE COLUMBIA RIVER WATERS. NOT WELL-ROUNDED, AS A RULE. ONE HAD FAINT STRIAE, LONGITUDINALLY ORIENTED.

SURFACE OF BASALT DECAYED BENEATH THE PARADISE FLATS DEPOSIT. IN SOME SECTION, THE UPPER 10-12 FEET WAS REDUCED TO INCOHERENT DECAYED MATERIAL WITH SCATTERED BOULDERS OF DISINTEGRATION THIS DECAY OCCURRED BEFORE THE PARADISE FLATS DEPOSIT WAS MADE. AND THE CONDITIONS WHICH BROT COLUMBIA RIVER WATERS HERE DID NOT REMOVE THE LOOSE DETRITAL MANTLE ROCK. THE DEPOSIT THEREFORE IS NOT A RECORD OF THE DOWNCUTTING OF THE COLUMBIA VALLEY ORIGINALLY, ELSE IT WOULD LIE ON SCOURED BASALT. IT RECORDS RISING WATERS AFTER THE UPLAND SLOPES HAD BEEN DEEPLY WEATHERED. A RELIEF OF 30-40 FT IN THE SURFACE OF THE BASALT BENEATH THE PARADISE FLATS DEPOSIT IN HALF A MIEE ALONG THE CONNELL NORTHERN. #

BONES OF A LARGE HERBIVORE IN PARADISE FLATS DEPOSIT. AN AXIS AND THE END OF A LONG BONE, WITH PULLEY-WHEEL ~~DENTITION~~ ARTICULATION, SECURED. OTHER MATERIAL TOO FRAGMENTARY AND TOO SCATTERED TO COLLECT. ((PAUL MILLER SAYS THE AXIS IS THAT OF A RHINOCEROS))

CONNELL TO KAHLOTUS JULY 27 1923

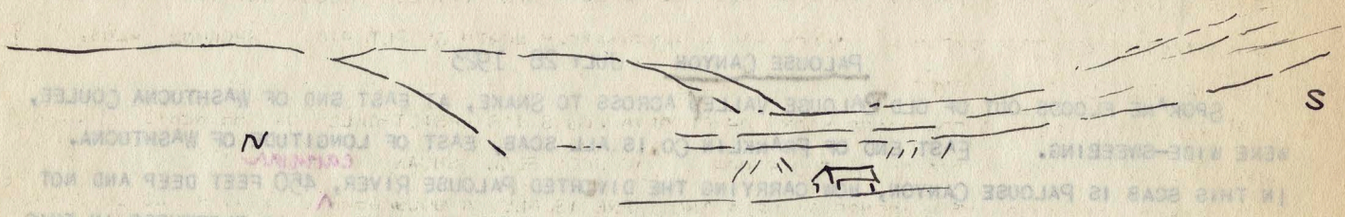
WASHTUCNA COULEE WAS A PRE-SPOKANE DRAINAGE LINE. GOOD EVIDENCE IN ORIENTATION OF DRAINAGE FROM UPLAND ON THE NORTH. HARDESTY COULEE AND RATTLESNAKE ~~COULEE~~ CANYON ARE EXAMPLES. MOUTH OF HARDESTY COULEE LARGELY FILLED WITH GRAVEL, INTO WHICH A RAVINE 100 FT MAX DEPTH HAS BEEN CUT IN POST-SPOKANE TIME. RAVINE VERY DIFFERENT IN FORM FROM THE COULEE BOTTOM UPSTREAM AND ABOVE THE LEVEL OF THE GRAVEL FILL. THERE IT IS A WIDE-OPEN, MATURE VALLEY. FROM RELATIONS OF BASALT LEDGES IN NORTH WALL OF WASHTUCNA COULEE TO THE GRAVEL FILL OF HARDESTY COULEE THIS TRIB ENTERED THE MAIN AT AN ALTITUDE AT LEAST 50, AND NOT TO EXCEED 100 FT ABOVE LEVEL OF SULPHUR LAKE. THIS IS AN APPROXIMATION OF THE AMOUNT OF DEEPENING WHICH WASHTUCNA SUFFERED DURING SPOKANE OCCUPATION. (SEE NOTES FOR AUG 21 AND AUG 19)

AN AREA OF SCABLAND ON SOUTH SIDE OF WASHTUCNA A MILE WEST OF SULPHUR STA. IT IS A ROCK TERRACE ABOVE THE COULEE WALLS. ALTITUDE BETWEEN 1100 AND 1150. ROAD SKIRTS SOUTH EDGE OF IT. TYPICAL SPOKANE TALUS. UPLAND TO SOUTH DESCENDS TO IT BY THE OLD RIVER CHANNEL BLUFFS OF PRONOUNCED DEVELOPMENT, 50 FT HIGH AND 30° SLOPES. ROAD CUT IN BASE OF ONE OF THESE STEEP SLOPES SHOWS LOESS WITH MUCH CALCAREOUS DEPOSITION, IN TUBULES AND ESPECIALLY ALONG STRATIFICATION PLANES THIS MATERIAL IS PROBABLY THAT WHICH CONSTITUTES THE UPLAND ROLLING TOPOGRAPHY THO IT MAY BE POSSIBLE THAT IT IS A LATER DEPOSIT MADE AT THE FOOT OF THE OLD BLUFF.

TRAVERSE SOUTH FROM SULPHUR TO DUNNIGAN COULEE, THENCE EAST AND NORTHEAST TO KAHLOTUS. TOPOGRAPHY OF THIS UPLAND HAS SOME PECULIAR FEATURES. AS SHOWN ON CONNELL QUADRANGLE, THE MAIN VALLEYS (OLD MAID AND DUNNIGAN COULEES, RYE GRASS FLAT) DRAIN SW BY W, WHILE NEARLY ALL THE SMALLER ONES DRAIN SW BY S. THE DETERMINATION OF THIS CURIOUS PATTERN (FOR IT CANT BE COINCIDENCE) IS NOT STRUCTURE OF BEDROCK FOR THE LOESSIAL MANTLE IS 80 FT IN DEPTH IN THE MAIN VALLEYS, ACCORDING TO WELL RECORDS, AND ALL HILLS AND VALLEYS ARE FASHIONED IN THE LOESS.

THE GENERAL EXPRESSION OF THE TOPOGRAPHY IS TYPICALLY OF THE PALOUSE HILLS TYPE. BUT THIS LATTICE-ASKEW PATTERN IS DIFFERENT FROM THE DENDRITIC PATTERN OF WHITMAN CO. AND THERE ISNT MUCH CONCAVITY OF PROFILES. THE SLOPES SEEM TO INDICATE THAT THIS REGION IS EARLIER IN THE CYCLE.

ANOTHER PECULIAR THING SEEN IN THE TWO COULEES, OLD MAID AND DUNNIGAN, AND SHOWN ON THE MAP IN RYEGRASS FLAT, IS THE NOTEWORTHY DIFFERENCE IN CHARACTER OF THE TWO SLOPES. THE SLOPE FROM THE SOUTH IS VERY GENTLE, MOST PROFILES SHOWING 2° TO 2 1/2°. THE SLOPE FROM THE NORTH THRUOUT IS MUCH STEEPER, AVERAGING 10° BUT BEING EVEN STEEPER AT THE BASE WHERE DRAINAGE HAS RECENTLY UNDERCUT THE LOWER PART. ACCOMPANYING SKETCH SHOWS RELATIONS.



(SEE NOTES FOR AUG. 21)

FURTHERMORE, THESE SLOPES ARE AFFAIRS OF AN EARLIER STAGE IN VALLEY DEVELOPMENT FOR THE 2°-2 1/2° SLOPE IS ENTRENCHED BY RAVINES 30 TO 50 FEET DEEP. THE MAP SHOWS THESE RATHER IMPERFECTLY. THEY APPEAR TO BE A RECORD OF RECENT REJUVENATION AND MAY BE SO DISMISSED AT PRESENT.

BUT THE DIFFERENCE IN SLOPE OF THE TWO SIDES !! IT MAY BE THAT THIS SHOULD BE LOOKED AT FROM THE VIEWPOINT OF DIVIDES, INSTEAD OF VALLEYS. THEN THE SCHEME WOULD BE—— LONG RIDGES, BROKEN INTO HILLS, CUT BY DRAINAGE LINES, YET MAINTAINING A PREVAILING LONG NORTHEN SLOPE AND STEEP SOUTHERN SLOPE. CAN THIS SHAPE BE DUE TO LOESSIAL ACCRETION ORIGINALLY ? IF SO, WHAT DETERMINES THE PERSISTENT ORIENTATION, ABOUT 45° TO THAT OF THE RIDGES ? SOME OF THESE VALLEYS ACROSS THE DIVIDES, THO HIGHER OF COURSE ON THE AXIS, REALLY, THEY ARE TWO VALLEYS, DRAINING IN OPPOSITE DIRECTION, IF THEY ARE OF STREAM ORIGIN. BUT IF DUE TO WIND, THEN SINGLE VALLEYS, FOR THE WIND CURRENTS FLOW COMPLETELY ACROSS, OF COURSE.

THE BEST EVIDENCE AS TO THE LOESSIAL CHARACTER OF THE SUPERBASALT SEDIMENT IS AFFORDED BY A ROAD CUT ON THE WESTERN BRINK OF DEVILS CANYON, A MILE AND A HALF IN A DIRECT LINE SOUTH OF KAHLOTUS. HERE THE GLACIAL STREAM WHICH CUT THE CANYON MADE A STEEP SCARP IN THE LOESS AND THE ROAD GRADING HAS EXPOSED MATERIAL WHICH ORIGINALLY WAS AT THE BASE IN THE CENTER OF THE HILL. IT IS LOESS, AND FULL OF SECONDARY LIME IN SEAMS AND ROOTLET CASTS. THESE ROOT CASTS ARE INDISPUTABLE. SOME ARE SHELLS DEPOSITED AROUND SAGE ROOTS, 2-3 INCHES IN DIAMETER, IDENTICAL WITH THOSE SEEN IN PRESENT SOILS AT COLD SPRINGS RESERVOIR. FURTHERMORE, THERE ARE AT LEAST THREE REDDENED ZONES IN THE CUT, DOUBTLESS OLD OXIDIZED SURFACES, LATER BURIED IN THE ACCUMULATING LOESS

DEVILS CANYON IS A SMALL BUT WONDERFUL EXAMPLE OF WHAT THE SPOKANE FLOODS DID IN THE COLUMBIA PLATEAU COUNTRY. THE FLOOD WATERS REACHED TO 1000 OR 1150. ABOVE THIS LEVEL ARE THE STEEPENED SLOPES OF THE LOESS, 30°–33°, FACING SCABLAND BELOW THAT LEVEL. SCABLAND A LITTLE WIDER THAN THE TOP OF THE CANYON, ESPECIALLY AT JUNCTION OF WASHTUCNA COULEE AND DEVILLS CANYON. THE FLOOD FOUND A SMALL LEAK SOUTHWARD ACROSS THE PALOUSE HILLS TOPOGRAPHY AT KAHLOTUS AND A DEEP SNAKE RIVER CANYON INTO WHICH IT PLUNGED. RAPIDS, CASCADES AND FALLS OVER THE EDGES OF THE BASALT FLOWS AT ONCE DEVELOPED AND RETREATED NORTHWARD. THIS SHORTLY CONCENTRATED THE WATER INTO THE CANYON PROPER. A FALL AT ONE LEVEL, BELOW THE BRINK OF THE CANYON, WAS DOUBLE AT ONE STAGE. THE ABANDONED HALF, WITH A GOAT ISLAND BETWEEN IT AND THE MAIN CANYON, IS ABOUT HALFWAY BETWEEN WASHTUCNA COULEE AND SNAKE RIVER. THE HALF OF THE FALL WHICH WON ALL THE DRAINAGE RETREATED ALMOST TO WASHTUCNA COULEE WHEN THE SPOKANE DRAINAGE FAILED AND THE CANYON WENT DRY, NEVER TO CARRY WATER AGAIN.

DUE TO THE DEPTH OF THE CANYON, THE MINOR DRAINAGE LINES FROM THE PALOUSE HILLS COUNTRY IMMEDIATELY EAST HAVE DEEPENED IN POST–SPOKANE TIME AND CUT CONSIDERABLY INTO BASALT, THE LEDGES OF WHICH SHOW PLAINLY ON THE LOWER SLOPES. THEIR PROFILES ARE THOSE OF REJUVENATED VALLEYS, ALSO IRREGULAR, ERODED SURFACE OF BASALT BENEATH THE LOESS HILLS. RELIEF OF 50 FT IN 1/2 MILE.

PALOUSE CANYON JULY 28 1923

SPOKANE FLOODS OUT OF OLD PALOUSE VALLEY ACROSS TO SNAKE, AT EAST END OF WASHTUCNA COULEE, WERE WIDE–SWEEPING. EAST END OF FRANKLIN CO. IS ALL SCAB, EAST OF LONGITUDE OF WASHTUCNA. IN THIS SCAB IS PALOUSE CANYON, NOW CARRYING THE DIVERTED PALOUSE RIVER, 450 FEET DEEP AND NOT MORE THAN TWICE AS WIDE AS DEVILS CANYON. SPOKANE TALUS EVERYWHERE. AS ELSEWHERE IN THIS REGION, TALUS COMMONLY IS GRASSED, AND AT THE FOOT IS A FLATTENING OF THE SLOPE. BUT SLOPES STAND 30°–35°, A FAILURE TO ACCORD WITH OBSERVATIONS MADE LAST SUMMER.

Err. GRANITE BLDR AT PARK STATION, AT BRIDGE IN CANYON. LATERAL CANYON UNITES WITH PALOUSE FROM WEST, A LITTLE BELOW BRIDGE. DID NOT CUT DOWN TO FLOOR OF MAIN CANYON. AT ITS MOUTH IS A SPLENDIDLY SHAPED BAR, WITH PROFILES ADJUSTED TO SUBAQUEOUS SWIRL OF THE WATERS. IT IS NOT A TERRACE FRAGMENT. THERE IS NO GRAVEL AT ALL IN THE CANYON ABOVE THE BRIDGE.

DIFFERENCE IN ALTITUDE OF FLOOR OF WASHTUCNA COULEE AND PALOUSE CANYON AT HEAD IS VERY LITTLE.

VIEW OVER SCABLAND AND CANYON FROM PALOUSE HILLS ON THE WEST IS SUPERB. THIS LOWER PALOUSE SCABLAND IS PERHAPS 10 MILES WIDE AT THE NORTH AND NARROWS TO ABOUT 5 MIEES NEAR THE SNAKE. IT IS FEATURED BY NUMEROUS CANYONS, EXTINCT WATERFALLS, ETC. OVER THE BROAD FLAT AND CARRIES THE STRIKING PALOUSE CANYON IN ITS CENTRAL PORTION.

THE SCABLAND IN GENERAL SHOWS LESS ROCK THAN OTHER SPOKANE SPILLWAYS SEEN TO DATE. THE COVER IS A FINE SOIL, NOT THE PRODUCT OF BASALT DISINTEGRATION. THE TALUS, WHERE CUT BY THE RR. HAS CONSIDERABLE VERY FINE MATERIAL IN IT. BOTH THESE THINGS SEEM TO INDICATE DEPOSITION OF WIND–BLOWN DUST IN UNUSUAL AMOUNT DURING POST–SPOKANE TIME.

PALOUSE CANYON WAS PROBABLY FORMED BY RECESSION OF FALLS AND CASCADES. AS EVIDENCE FOR THIS IT IS TO BE NOTED THAT SOME OF THE CANYONS ON THE GENERAL SCABLAND, RELATIVELY SHALLOW OF COURSE, COMPARED WITH THE PALOUSE CANYON, PLUNGE ABRUPTLY INTO THE LOWER PART OF THE CANYON AND HAVE SHORT GORGES AND ABANDONED FALLS 1000 TO 2000 FEET BACK FROM THE MAIN CANYON. SINCE THESE CANYONS COULD HAVE CARRIED SPOKANE WATERS ONLY WHEN THE WIDE SCABLAND AT THE NORTH HAD NO DEEP CANYON IN IT ((OR—— WHEN THE WIDE SCABLAND WAS COMPLETELY FLOODED FROM THE NORTH)), AND

THEIR RELATIONS TO THE LOWER CANYON INDICATE THAT IT EXISTED DURING THEIR ACTIVITY, IT FOLLOWS THAT THE PALOUSE CANYON WAS NOT ERODED UNIFORMLY ALONG ITS ENTIRE LENGTH BUT BEGAN AT SNAKE RIVER AND LENGTHENED BY HEADWARD RECESSION, THE ORIGINAL BASALT BARRIER SOUTH OF PALOUSE FALLS STA (O-W) REMAINING UNTIL LATE IN THE HISTORY OF THE WHOLE SCABLAND DEVELOPMENT. (or the volume very great do she very last!

SNAKE RIVER CANYON IN THE SPOKANE EPOCH WAS PROBABLY AS DEEP AS IT NOW IS. THIS IS SHOWN BY THE CHARACTER OF TRIBUTARY VALLEYS ABOVE THE MOUTH OF THE PALOUSE. THEY HAVE WELL-GRADED SLOPES, THO CUT IN BASALT FOR SEVERAL 100 FEET.

FURTHER EVIDENCE FOR THIS CONCLUSION IS THE CHARACTER OF THE MOUTH OF PALOUSE VALLEY AT PERRY. TWO CANYONS EXIST HERE, ONE CARRYING THE PALOUSE AND ONE DRY. A MESA OF BASALT STANDS BETWEEN, PERHAPS ORIGINALLY ANOTHER GOAT ISLAND. IT IS NEARLY IN THE CENTER OF THE VALLEY AND ITS SUMMIT IS 350 FT. PERHAPS 400 FT. ABOVE SNAKE RIVER. IT IS A PART OF THE ORIGINAL N. WALL OF SNAKE RIVER VALLEY HERE. THE HIGHEST SCABLANDS HERE ARE AT LEAST 500 FT ABOVE SNAKE RIVER. THEY LIE ON THE MARGINS OF THE TRACT, OF COURSE, AND ARE THE HIGHEST BASALT, BEING IMMEDIATELY OVERLAIN BY THE LOESS. THE SPOKANE FLOOD WHICH BROKE SOUTHWARD ACROSS THE PRE-SPOKANE PALOUSE HILLS ON THE DIVIDE, PLUNGED OVER A BASALT WALL 350 TO 500 FT HIGH TO REACH SNAKE RIVER. SUCH A GIGANTIC CASCADE HAD ENORMOUS EROSIVE POWER AND THE FALLS AND CASCADES GENERATED SAPPED NORTHWARD, CONCENTRATING IN PALOUSE CANYON, UNTIL THE BARRIER WAS ENTIRELY REMOVED AND ALL POST-SPOKANE PALOUSE DRAINAGE HAS GONE THIS WAY.

THE SCARPS OF THE PALOUSE HILLS FACING THE SCABLAND ARE EXCEEDINGLY INSTRUCTIVE. THEY MAY BE RECOGNIZED PLAINLY ALONG THE ENTIRE LENGTH OF THE TRACT BETWEEN THE HEAD OF WASHTUCNA COULE AND SNAKE RIVER. THEIR SLOPE, ABOVE THE BASAL PORTION, IS 33° ALMOST INVARIABLY.

PALOUSE FALLS PLUNGES 198 136 FEET SHEER. THE STREAM FLOWS IN A SERPENTINE NARROW BOX CANYON FOR A MILE ABOVE THE FALLS. ABOUT 100 FEET DEEP. THIS CANYON ABOVE THE FALLS, THE FALLS THEMSELVES AND THE CANYON FOR SOME DISTANCE BELOW, LEFT BY RECESSION OF THE FALLS, APPEAR TO BE OF POST-SPOKANE ORIGIN.

ALL TOLD, SPOKANE FLOODS APPEAR TO HAVE CUT AT LEAST 500 FEET INTO THE BASALT AT THE HEAD AND FOOT OF PALOUSE CANYON.

GREAT GRAVEL DEPOSITS IN SNAKE RIVER VALLEY BETWEEN MOUTH OF PALOUSE AND RIPARIA. ON THE SOUTH SIDE, THERE IS LESS GRAVEL BUT PROMINENT FLAT TOPS TO THE TERRACES. THESE ARE THE TERRACE WHICH RUSSELL NOTES, AVERAGING 360 FT ABOVE THE SURFACE OF THE RIVER. SECTIONS ALONG NPRR ON NORTH SIDE OF RIVER SEEN FROM TRAIN. PREVAILINGLY FORESET-BEDDED AND PREVAILINGLY THE BEDDING DIPS UPSTREAM. EXCEPT NEAR RIPARIA, THE EXCEPTIONS TO THIS ARE RARE. THIS MEANS SOMETHING UNSUSPECTED BEFORE. WHILE A FEW REVERSE FORESET BEDS MAY BE PERMITTED, IN EDDIES ALONG THE SHORE, IT SEEMS IMPOSSIBLE TO ALLOW ALL OF THESE. MORE MUST BE SEEN IN THE FIELD BEFORE HYPOTHESES WILL BE WORTH WHILE.

RIPARIA TO LACROSSE BY TRAIN JULY 29 1923

O-W RR FOLDOWS CANYON OF ALKALI CREEK TO HAY, AND A TRIBUTARY FROM THERE TO JERITA WHICH IS ESSENTIALLY ON THE DIVIDE BETWEEN ALKALI CREEK DRAINAGE AND WILLOW CREEK DRAINAGE.

THE DRAINAGE SYSTEM OF ALKALI CREEK IS A PERFECT EXAMPLE OF MATURITY IN A REGION OF HIGH RELIEF. THE ORIGINAL PLATEAU REMNANTS REACH ABOUT 1800 A.T. WHILE THE MOUTH OF ALKALI CREEK IS 550A.T. THE HIGH POINT ON THE O-W RR BETWEEN LACROSSE AND RIPARIA IS ABOUT 1600.

FOR THE LOWER SIX MILES (TO CANYON STA) THE RISE OF THE VALLEY BOTTOM IS BUT 175 FT. FOR

THE SEVEN MILES BETWEEN CANYON AND HAY, THE RISE IS 325 FEET. FOR THE SIX MILES BETWEEN HAY AND JERITA, THE RISE IS 500 FEET. THERE IS A VALLEY FLAT ALL THE WAY, THO IT IS NARROW. AT HAY IS ROOM ENOUGH FOR A VILLAGE AND THERE ARE MANY RANCH BUILDING GROUPS ON THE FLOOR. THE TRIBUTARY SYSTEM IS BEAUTIFULLY DEVELOPED, ALL OF THE AREA BEING IN SLOPES. NO SUMMIT FLATS REMAIN. ALMOST ALL SLOPES ARE GRADED THO THE SCABBY EDGES OF FLOWS SHOW HERE AND THERE. THERE ARE NO CANYONS IN THE GROUP. OBVIOUSLY, THIS DRAINAGE SYSTEM HAS BEEN DEVELOPING FOR A VERY LONG TIME WITH SNAKE RIVER VALLEY ESSENTIALLY AS DEEP AS IT NOW IS. VERY MUCH LONGER THAN THE LENGTH OF POST-SPOKANE TIME.

ANOTHER THING OF MUCH SIGNIFICANCE IS THE FACT THAT THIS SYSTEM IS DEVELOPED IN BASALT. BASALT SHOWS IN RR CUTS ALL THE WAY TO, AND AT, THE SUMMIT. THO LOESS, RATHER PALE IN COLOR, IS ALSO SHOWN IN THESE CUTS, IT IS BUT A MANTLE ON THE SLOPES OF THE BIG BASALT HILLS. IT DOES NOT OCCUR TO ANY EXTENT DOWN IN THE VALLEYS BUT IS PROMINENT ON THE ROLLING UPLAND.

THE DEGREE TO WHICH THIS UPLAND IS DISSECTED SUGGESTS THAT TOPOGRAPHICALLY IT BELONGS TO AN OLDER CYCLE. IF THERE IS ANY LOESS FORMATION ON TOP THE BASALT ABOUT LACROSSE, IT LIES ABOVE THE JERITA ~~FLAT~~ LEVEL.

THE DIVIDE BETWEEN WILLOW AND ALKALI CREEKS IS 18-20 MILES BY STREAM, 9-10 MILES BY DIRECT LINE, FROM SNAKE RIVER. IT IS ONLY TWO MILES FROM WILLOW CREEK. ALKALI CREEK FLOWS IN A NORMAL RELATION TO SNAKE RIVER, CONVERGING WITH AN ACUTE ANGLE ON UPSTREAM SIDE. WILLOW CREEK, LIKE THE PRE-SPOKANE PALOUSE, FLOWS PARALLEL WITH THE SNAKE. UNION FLAT CREEK IS AN EVEN MORE REMARKABLE EXAMPLE OF THIS PARALLELISM. AND THERE ARE MANY OTHERS. EXPLANATION?? LACROSSE IS ABOUT 125 FEET LOWER THAN THE DIVIDE (SEE AUG 31 NOTES) BETWEEN WILLOW AND ALKALI CREEKS.

LACROSSE TO HOOPER JULY 29 1923

NORTHWARD AND NORTHEASTWARD FROM LACROSSE, THE MATURE TOPOGRAPHY OF LOW, GENTLE SLOPES IS INTERRUPTED BY THREE PROMINENT DEEP, WIDE NOTCHES, CUT DOWN TO THE LEVEL OF THE FLAT ON WHICH THE TOWN IS BUILT, AND THUS ISOLATING TWO BIG HILLS FROM THE REST OF THE PALOUSE HILLS TOPOGRAPHY. THE SIDES OF THESE NOTCHES ARE STEEP, PERHAPS 30°, THO A PROPER POSITION FOR SIGHTING ON THEM WAS NOT SECURED. AT LACROSSE AND WESTWARD TO BENNER, WILLOW CREEK FLAT IS FLOORED WITH BASALTIC RUBBLE, RANGING IN SIZE FROM PEBBLES TO SMALL BOULDERS. HERE AND THERE IS A BIT OF BARE BASALT, CONSTITUTING A LOW KNOLL. A CAREFUL WATCH ALL THE WAY TO BENNER DISCLOSED ONLY TWO PIECES OF ROCK, OTHER THAN THE BASALT AND THE CALICHE-LIKE CALCAREOUS MATERIAL COMMON IN THE PLATEAU. THESE WERE SMALL BOULDERS OF GRANITE, CLOSE TOGETHER AND PROBABLY ONE ORIGINALLY. THE LARGER FRAGMENT IS 2 FT MAXIMUM DIAMETER. THEY LIE 2 MI. WEST OF LACROSSE IN THE FIELD ON THE NORTH OF THE ROAD.

AT BENNER IS A SAND AND GRAVEL PIT. THE MATERIAL IS ALMOST WHOLLY BASALT. AMONG HUNDRED OF BOULDERS AND COBBLES REJECTED AS TOO LARGE FOR THE CRUSHER, ONLY FOUR FOREIGNERS WERE FOUND; THREE DIFFERENT GRANITES AND ONE SILICEOUS METAMORPHIC SHOT WITH VEIN ~~STUFF~~ QUARTZ.

THIS DEPOSIT AT BENNER CONSTITUTES A TERRACE, FACING WEST. THE DESCENT OVER THE SCARP IS 50 FEET. THE GRAVEL AND SAND EXPOSED ARE WELL SORTED AND STRATIFIED, COARSER COBBLES IN UPPER PART AND FINE SAND IN BOTTOM OF THE PIT. THERE IS NO EVIDENCE OF CEMENTATION OR STAINING; THE MATERIAL SEEMS AS FRESH AS THE GRAVEL IN THE SPOKANE SCABLANDS.

NOW THE COMBINATION OF THE THREE STEEP-SIDED NOTCHES NORTH, NORTHEAST OF LACROSSE AND THE GRAVEL FILLING AND SCATTERED SCABBY KNOBS OF BASALT LOOKS SUSPICIOUSLY LIKE GLACIAL DRAINAGE FROM THE NORTH. ADD TO THAT THE ERRATIC COBBLES AND BLDRS FOUND, AND THE CASE IS ESTABLISHED. GLACIAL WATERS DID GO THRU THE WINONA-LACROSSE ROUTE, WHICH WAS INDICATED AS DOUBTFUL IN MY BGSA ARTICLE/ MAP.

NOW, WAS THIS SPOKANE DRAINAGE? OR EARLIER? AN EXAMINATION OF THE FOLLOWING CRITERIA WAS MADE: (1) SLOPES OF THE LOESS HILLS FACING THE CHANNEL

(2) THE CHARACTER OF THE GRAVEL

(3) THE CONDITION OF THE TERRACES

(4) THE SCABLAND CHARACTER (ESP. TALUS)

(5) THE RELATIONS OF THE MOUTH OF THIS DRAINAGE LINE TO THE PALOUSE SCABLAND.

(1) THE SLOPES ARE APPARENTLY STEEP ENOUGH TO BE SPOKANE. (2) THE GRAVEL IS FRESH ENOUGH AND UNCONSOLIDATED. (3) THE TERRACES ARE CONSIDERABLY DISSECTED, AND WHOLLY ABSENT AT PAMPA; INDEED, FROM BENNER TO THE PALOUSE SCABLAND. (4) NO SCABLAND PRESENT, OR ONLY SUGGESTIONS OF IT. THIS BECAUSE THE STREAM HAD ONLY A LOW GRADIENT. HENCE, NO TALUS BY WHICH TO JUDGE. (5) THE TERRACE GRAVEL AT THE JUNCTION OF WILLOW CREEK AND PALOUSE SCABLAND AREA LIES BELOW THE HIGHEST SCABLAND LEVELS AND BLENDS INTO THE TERRACES DEPOSITED HERE BY WATERS COMING DIRECTLY FROM THE NORTH.

ALL TOLD, IT IS SPOKANE IN AGE. LITTLE DAMAGE WAS DONE TO THE BASALT BENEATH, HOWEVER. STILL, THE QUANTITY OF BASALT RUBBLE AND GRAVEL AND SAND SUGGEST THAT FARTHER NORTH, GREATER EFFECT ON THE BED ROCK SHOULD BE FOUND. (See Aug 22-23)

VERY LITTLE IN THE WAY OF GRANITE BOULDERS ON THE SCABLAND BETWEEN PAMPA AND HOOPER. THIS IS SIMILAR TO THE SITUATION ON THE SCABLAND BETWEEN HOOPER AND SNAKE RIVER. IT MAY BE BECAUSE LESS FLOATING ICE CAME THUS FAR, AND IT MAY BE BECAUSE POST-SPOKANE DUST DEPOSITS HAVE COVERED MUCH OF THIS MATERIAL.

HIGHEST SCABLAND ON THE SOUTH NEAR HOOPER IS 350 FEET ABOVE PALOUSE RIVER BOTTOMS. ON NORTH ON THE BENGE-HOOPER ROAD, HIGHEST SCABLAND DIRECTLY NORTH OF PALOUSE RIVER IS 500 FEET ABOVE THE BOTTOM LANDS. PALOUSE HERE HAS NOT CUT MORE THAN 15 FEET IN BASALT SINCE THE SPOKANE FLOODS SUBSIDED. BOTTOM LANDS ARE ESSENTIALLY AS LEFT THEN AND POSSIBLY THEY ARE ESSENTIALLY THE PRE-SPOKANE VALLEY FLOOR. A LITTLE MORE CUTTING IN THE CANYON, HOWEVER, AND TRENCHING WOULD HAVE OCCURRED AT HOOPER. Yes. See old irrigation ditch to carry Palouse River water into Washtucna Coulee.

HOOPER TO LANTZ JULY 30 1923

ONLY A CAREFUL, DETAILED EXAMINATION CAN MAP THE RELATIONS OF SCABLAND AND PALOUSE HILLS IN THIS AREA BETWEEN PALOUSE RIVER AND COW CREEK. THERE ARE MANY ISOLATED GROUPS OF PALOUSE HILLS, SHARPENED ON THE SLOPES, UNTIL THEY LOOM UP ON A HAZY DAY LIKE SMALL MOUNTAINS ABOVE THE SCABLAND. THERE ARE ALSO MINOR CHANNELS AMONG THESE PALOUSE HILLS, CROSSING THE GROUPS, BUT NOT ERODED ENOUGH TO HAVE A SCABLAND FLOOR. CANYONS IN THE SCABLAND, PARALLEL TO EACH OTHER, ARE LIMITED TO THE FIRST FEW MILES NORTH OF THE PALOUSE (EXCEPT COW CREEK VALLEY). THIS IS BECAUSE ONLY AS THE GLACIAL WATERS CAME OFF THE SCABLAND DOWN INTO THE PRE-SPOKANE PALOUSE VALLEY, WAS THEIR GRADIENT SUFFICIENT TO ERODE CANYONS. COW CREEK FLOWS IN A PRE-SPOKANE VALLEY.

GRANITE BLDRS MORE COMMON THAN SOUTH OF THE PALOUSE AND THE LATITUDE OF HOOPER. ONE, 3 1/2 FEET MAX. DIAMETER, 2 MILES OUT OF HOOPER ON BENGE ROAD.

NORTH FROM BENGE TO LANTZ, THE N-S ROAD TRAVERSES A GRAVEL FLAT ALL THE WAY. GRAVEL PIT IN THE SCARP JUST NORTH OF BENGE, NOTED EARLIER. THE CHANNEL HERE IS 1 1/2 MI — 2 MILES WIDE AND HAS BUT LITTLE SCABROCK. WHAT IT HAS LIES ON ITS WESTERN SIDE. ROAD IS ALONG FOOT OF THE EASTERN BLUFFS.

SCARPED PALOUSE HILLS VERY PROMONENT. THE SCARPS ARE ALL ALIGNED, AND THEY TRUNCATE HILL TOPS AND VALLEYS ALIKE. MOST OF THESE VALLEYS HAVE BEEN LEFT HANGING. WHERE SUFFICIENT DRAINAGE HAS COME BY WAY OF SOME ONE OF THESE VALLEYS SUBSEQBENT TO THE SCARPING, NARROW GULCHES HAVE BEEN CUT BACK INTO THE PALOUSE HILLS. THIS, BY THE WAY, IS ADDITIONAL EVIDENCE THAT NO BASALT EXISTS IN THE PALOUSE HILLS OF THIS REGION. WHERE THE TRUNCATED VALLEY DRAINED AWAY FROM THE SCABLAND TRACT, THERE HAS BEEN NO CHANGE IN ITS CROSS SECTION SINCE THE SCARP WAS MADE. THE FACES OF THE SCARPS IN GENERAL ARE SCARCELY FURROWED BY EROSION YET, AND NOT RAVINED AT ALL.

CONCERNING PARDEE'S GLACIAL TILL AT KAHLOTUS, LACROSSE, WINONA, LANTZ AND "SCORES" OF PLACES IN ADAMS, WHITMAN AND ADJACENT COUNTIES.—— THE KAHLOTUS AND LANTZ REGIONS HAVE BEEN EXAMINED SUFFICIENTLY TO JUSTIFY A JUDGMENT AND THE GENESIS/ OF THE FEATURES AT LACROSSE IS FAIRLY CLEAR. THE LANTZ SITUATION IS SIMPLE. THERE IS ONLY ONE SECTION OF PLEISTOCENE MATERIAL OF ANY IMPORTANCE "NEAR" LANTZ AND THAT IS A 7 OR 8 FOOT CUT IN LOESS ON THE EAST BLUFF OF THE GRAVEL-FLOORED CHANNEL WHICH LEADS TO BENGE. THERE ARE NODULES, ROOT CASTS, ROOTLET CASTS AND SEAMS (ALONG STRATIFICATION PLANES) OF LIME IN THIS LOESS (ALSO A RIB-BONE, MUCH CRUMBLED), BUT NOTHING TO SUGGEST THAT IT MIGHT BE A TILL. ONE OTHER PLACE "NEAR" LANTZ WHICH SEEMS TO BE THE LOCALITY PARDEE HAD IN MIND IS BETWEEN THE LANTZ FARM AND THE SP AND S RR, ALONG THE ROAD. HERE IS A LARGE BOULDER BAR, DEPENDING FROM A PALOUSE HILL GROUP A MILE TO THE NORTH. SPOKANE WATERS WENT AROUND THIS GROUP BUT DID NOT SCOUR DEEPLY ON THE WEST SIDE WHERE THE MAIN BENGE-LANTZ RANGE OF PALOUSE HILLS LIES. THE UNDERLYING BASALT HERE IS COMPOSED OF LARGE COLUMNS AS SHOWN IN THE SCABLAND HALF A MILE FARTHER EAST, AND BLDRS OF DECOMPOSITION WERE AVAILABLE. THESE THE STREAM PILED IN A LONG BAR WHICH NARROWS AND LOWERS TO THE SOUTH UNTIL IT DISAPPEARS.

NOW, ON ~~THIS~~ OR IN THIS BAR ARE A FEW GRANITES. FOUR WERE SEEN ALONG THE ROAD, THE LARGEST HARDLY THREE FEET IN LENGTH. NONE ARE STRIATED. ONE LARGE BASALT BLDR., HOWEVER, CARRIES SOME STRIAE. THE STRIAE ARE ORIENTED WITH LONG AXIS OF BLDR, WHICH IS ABOUT 6 FEET IN LENGTH. BUT OCCUR ONLY NEAR ONE END. THE BLDR IS ROUNDED, HARDLY SUBANGULAR. ROUNDING PERHAPS BY STREAM WATER, PERHAPS ORIGINAL OUTLINES OF BLDR OF DECOMPOSITION. WHETHER OR NOT THESE ARE GLACIAL STRIAE IS A QUESTION. THEY DONT LOOK LIKE BRUISE MARKS WHICH MIGHT BE PROUCED IF FLOATING ICE HAD BEEN CONCERNED. YET IT ISNT APPARENT WHY THE STRIAE OCCUR ONLY NEAR ONE END.

ONE GRANITE HAS BEEN CHIPPED BY A HAMMER RECENTLY. PROBABLY PARDEE EXAMINED THIS PLACE, SAW THE GRANITES, THE STRIATED BASALT, THE BAR FORM AND THE SCABLAND AND THEREFORE INCLUDED LANTZ IN HIS CATALOG. A BOWLDERY TILL IN A MORAINAL RIDGE, HE PROBABLY CONCLUDED.

NOW, AT LANTZ AND KAHLOTUS, THE STORY IS CLEAR. THE CHANNEL-LIKE SCABLANDS, THE SCARPED LOESSIAL HILLS AND ALL RELATIONS INDICATE THAT THE CORRECT HYPOTHESIS IS THAT OF GLACIAL DRAINAGE, NOT GLACIAL ICE. PARDEE APPARENTLY HASNT FOUND TILL UNDER THE LOESS AND THEREFORE HASNT FOUND A TILL AT ALL. THE ONLY CHANCE OF HIS BEING RIGHT AND MY BEING RIGHT WAS TO HAVE HIS TILL "IN SCORES OF PLACES" PRE-LOESS IN AGE. MY INTERPRETATIONS OF LAST SUMMER HAVE BEEN SUBSTAN-

TIATED IN EVERY PLACE EXAMINED SINCE JULY 20 THIS SUMMER. THE ONLY CHANGE HAS BEEN THE DISCOVERY OF SPOKANE TALUS SLOPES OF 35°. ADDITIONS ENOUGH BUT ALL CAPABLE OF EXPLANATION ONLY BY THE HYPOTHESIS OF ENORMOUS AMOUNTS OF GLACIAL WATER. NO ICE, EXCEPT FLOATING ICE.

LATER—— PARDEE SAYS "A LARGE AREA WEST OF LANTZ" IF BY LANTZ, HE MEANS LANTZ RR STATION, THEN HE PROBABLY HAD THIS BOULDER BAR IN MIND. IF HE MEANS THE LANTZ P.O., THEN HIS LARGE AREA MUST BE ON THE SCABLAND WEST OF THE SCHOOLHOUSE. MUST SEE THIS WITH THE CAR.

HILLYARD. ONE MILE EAST. FOOT OF LITTLE BALDY. AUG. 2

QUARRY IN GRANITE AT FOOT OF HILL. GRANITE FINE-GRAINED, MUSCOVITE PROMINENT ON CLEAVAGE FACES, GNEISSIC STRUCTURE, JOINTED WITH APPARENTLY TWO SYSTEMS WHICH DIP STEEPLY AND STRIKE NW-SE APPROXIMATELY. SOME BLDRS OF COARSE-GRAINED GRANITE, WITH PROMINENT MUSCOVITE AND FLDSPR AND QTZ., APPARENTLY FROM PEGMATITE WHICH DOES NOT OUTCROP IN QUARRY FACE.

HILLYARD GRAVELLY TERRACE UNDULATING THRU A RANGE OF 10-20 FT IN 1000 FT. BUT NO GOOD CHANNEL FORMS SEEN.

PLEASANT PRAIRIE SCHOOL, 1 1/2 MILE EAST. GRAVEL PIT.

FLUVIOGLACIAL MATERIAL, MOSTLY ARKOSE FROM UNDERLYING GRANITE. DEPTH BUT A FEW FEET, DECAYED GRANITE BENEATH. MUCH FOREIGN MATERIAL, SOME OF IT BEAUTIFULLY STRIATED. NO TILL. STRIATED PIECES MUST HAVE FLOATED HERE ON ICE. ALTITUDE 2400+. EDGE OF BASALT FARTHER WEST AND HIGHER. EITHER ERODED FROM THIS PLACE OR NEVER REACHED HERE. PROBABLY THE FORMER.

SPOKANE VALLEY

BASALT IN BLUFFS NORTH OF VELOX, BUT NO FARTHER EAST. SLOPES MOSTLY GRANITE, HOWEVER.

BROAD CHANNEL IN V.T. BETWEEN VELOX AND MOAB. STEEPER WALL ON EAST SIDE BUT IT IS A TRUE CHANNEL, NOT THE DOWNSTREAM FACE OF A GREAT BAR. NPRR HAS FILLED ACROSS IT, PERHAPS 30 FT HIGH, TO MAINTAIN ITS GRADE.

V.T. DAM OF NEWMAN LAKE IS A TERRACE OF FINE GRAVEL, 40-50 FEET ABOVE MAIN V.T. THIS IS A MEASURE OF LOWERING DURING ITS BUILDING. or of depth of stream in which the bar was built across mouth of tributary valley.

NO GLACIAL DRIFT OF ANY KIND SEEN ABOUT NEWMAN LAKE. GRANITE IS STRIKINGLY FOLIATED AND THE BENDING OF THE FOLIA AND SUBSEQUENT CLEAVAGE HAS PRODUCED FRAGMENTS WHICH SUGGEST FLATTENED TREE TRUNKS IN SHAPE IN SIZE.

GRAVEL TERRACE, REMNANT OF BAR WHICH ORIGINALLY GAVE RISE TO THE LAKE, IS 45 FT ABOVE THE LAKE FLAT AND 70 FT ABOVE THE SPOKANE V.T. COMPOSED OF FINE GRAVEL, WHILE V.T. NEARBY AND LOWER, HAS LARGE NUMBERS OF GREAT ROLLED STREAM BOULDERS, 3-4 FT IN MAX DIA.

HAUSER (SUCKER) LAKE SIMILARLY DAMMED AND ITS BAR OF SIMILAR PROPORTIONS AND HEIGHTS. A PIT ON LAKEWARD SIDE SHOWS FORESET BEDDING, DIPPING TOWARD THE LAKE. EACH OF THE BARS WHICH ENCLOSE THE MARGINAL LAKES OF THE SPOKANE V.T. IS ESSENTIALLY A DELTA !

POST FALLS DUE TO V.T. HAVING COVERED SPUR OF GRANITE ORIGINALLY AHD STREAM HAVING CUT DOWN AND BECOME FIXT ON THE ROCK.

COL NORTH OF MICA USED BY ROAD EAST OF RR. COL HAS ABUNDANT GLACIAL ERRATIC MATERIAL. MANY DIFFERENT KINDS BUT BLUISH AND GREENISH FINE-TEXTURED QTZITE MOST COMMON. SAME MATERIAL FOUND ON HILL WEST OF MICA STATION AT 2550 RECORDS FLOATING ICE IN LATAH LAKE, WHICH BACKED UP IN EARLIER STAGE.

SPANGLE, FIVE MILES SOUTHEAST OF. SEC. 17 JULY AUG 3 1923

ROADSIDE SECTION, 25 FT ABOVE LATAH CREEK BED, IN LOESS AND RIVER SAND. LOESS WITH ROOTLET MARX BELOW SAND WITHOUT THEM. THEREFORE MADE DURING ACCUMULATION OF LOESS. 10 FT BELOW PRESENT SURFACE. ALSO EOLIAN CROSSBEDDING IN ONE PLACE. NOT LACUSTRINE ORIGIN. QTZITE AND PORPHYRITIC GRANITE COBBLES, THE QTZITE BEAUTIFULLY STRIATED.

SPLENDID CASE OF REJUVENTATION HERE; OLD LATAH CREEK VALLEY 2-3 MILES WIDE AND NEARLY FLAT, W/ NEW VALLEY WITH PLENTY OF VERTICAL BASALT.

BASALT IN ALL THESE PALOUSE HILLS, WELL UP. NO SEDIMENTARY DEPOSIT OF CONSEQUENCE TO MAKE THIS PALOUSE SOIL.

N.PINE CREEK—LATAH CREEK COL. AUG 3 1923

ABUNDANCE OF GRANITE BLDRS, ANGULAR, AT HEAD OF THIS CHANNEL, AT LEVEL OF FIRST CYCLE OF THE LATAH CREEK VALLEY. BUT NOT COMMON FARTHER SOUTH DOWN THE CHANNEL. SCABLAND AT COL, WHERE LAKES ARE LOCATED. EROSION 100 FT INTO BASALT AT ROAD CROSSING ABOUT 2 MILES NORTH OF THE PLACE WHERE RR ENTERS VALLEY. NO PRONOUNCED STEEPENING OF PALOUSE HILL SLOPES, PROBABLY BECAUSE ORIGINAL COL WAS LOW AND PINE CREEK ALREADY DOWN SUFFICIENTLY IN BASALT TO PREVENT SPREADING OF GLACIAL WATERS.

THERE ARE REALLY THREE CHANNELS HERE, THO ONLY TWO OPENINGS FROM LATAH LAKE. A MINOR CHANNEL, WITHOUT LAKES, AND WITH BUT LITTLE SCABLAND, LIES SOOTH OF THE OTHER TWO. IT IS A DISTRIBUTARY OF THE SOUTHERN ONE AS ORIGINALLY MAPPED.

SPANGLE AUG 3

GRANITE ERRATIC IN MIDDLE OF SEC 10, SE OFSPANGLE. ALTITUDE NEARLY 2500 MUST HAVE FLOAT-ED BACK ON ICE WHEN SPANGLE LOBE STOOD AT MAXIMUM.

THE SPANGLE-PLATONIC SCHOOL CHANNEL IS WELL-DEFINED, HAS SCAB BOTTOM IN PLACES, BASALT CLIFFS 50 FT HIGH IN PLACES, TALUS 4/5 UP ON CLIFFS, SWAMPS AND MEADOWS, WHICH ORIGINALLY WERE LAKES, GRANITE ERRATICS ON FLOOR AND STEEPENED PALOUSE HILLS BOUNDING.

SPOKANE TO NINE-MILE BRIDGE AUG. 3 1923

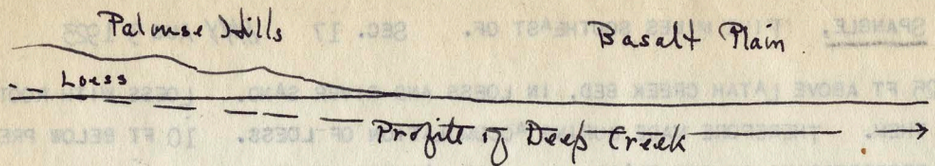
V.T. TERRACES PRESERVED IN EXTRAORDINARY SHARPNESS ALL THE WAY. MOST OF THE WAY ON BOTH SIDES. AVERAGE 500 ABOVE RIVER.

FOUR MOUND PRAIRIE, WEST OF NINE MILE BRIDGE, IS DETERMINED BY BASALT SURFACE. PLENTY OF GRANITE ERRATICS SCATTERED ALL OVER IT. BUT NO MORAINES SEEN. SOME SCABBY TRACTS OF BASALT BUT THESE ARE OLD BASALT HILL TOPS AND ARE NOT CHANNELLED SCABLAND. ONLY SUGGESTION OF CHANNELS WAS SEEN AT HORSESHOE LAKE AND THIS ISNT PRONOUNCED. IT IS CLOSE TO THE BASE OF PALOUSE HILLS.

NORTH OF HITE AUG. 3

PALOUSE HILLS TOPOGRAPHY TYPICALLY. LOESSIAL SOIL SHOWN IN CUTS AT LEAST 10-12 FT DEEP, PROBABLY NOT MUCH DEEPER. NO SUGGESTION OF MORAINE ALONG CONTACT OF BASALT PLAIN WITH GLACIAL ERRATICS AND THE PALOUSE HILLS TO THE WEST.

LARGER VALLEYS AMONG THESE PALOUSE HILLS ARE CUT BELOW THE LEVEL OF THE GLACIATED BASALT PLAIN (SUNSET PRAIRIE, AND FOUR MOUND PRAIRIE) DEEP CREEK DRAINAGE IS GATHERED LARGELY IN THESE PALOUSE HILLS AND CARRIED ACROSS BASALT PLAIN BUT BELOW ITS Summit LEVEL THO THE HILLTOPS ARE ABOVE



?- Is the loess as deep as this hypothesis requires?

IT APPEARS CLEAR NOW THAT THE INTERPRETATION SUGGESTED IN BGSA PAPER FOR DEEP CREEK VALLEY NEAR DEEP CREEK STATION, AND THE GENESIS OF THE BASALT PLAIN ITSELF, IS CORRECT.

BUT WHY NO MORAINE ALONG CONTACT OF BASALT PLAIN AND THE PALOUSE HILLS? ESPECIALLY NORTH OF HITE WHERE NO RUNNING WATER IN GREAT QUANTITY ESCAPED SOUTHWARD, AND COULD THEREFORE BE BLAMED FOR DESTRUCTION OF A MORAINE?

AT HITE AND AT CROSS ROADS ABOUT A MILE NORTH, BOTH IN VALLEYS IN THE PALOUSE HILLS, ARE CLAYEY GRAVEL DEPOSITS, LIMITED IN EXPOSURE, IF NOT IN ACTUAL EXTENT, WHICH CONTAIN PLENTY OF VARIOUS KINDS OF ROCKS, UNQUESTIONABLY DERIVED FROM GLACIAL ICE. THE DISTANCE TO THE GLACIATED BASALT PLAIN ISNT GREAT AND THESE TWO VALLEY DEPOSITS ARE LITTLE, IF AT ALL, ABOVE THE LEVEL OF THIS PLAIN. APPARENTLY THESE RECORD DEPOSITS IN PONDED WATERS BACK IN THE PALOUSE HILL MINOR VALLEYS, DUE TO PRESENCE OF ICE MARGIN ACROSS THEIR MOUTHS. SEVERAL CUTS, FRESHLY MADE, ACROSS PALOUSE HILL SUMMITS ON ROAD NORTH OF HITE, SHOW LOESS TO THE BOTTOM, 10-12 FT, OR NEARLY TO THE BOTTOM AND DECAYED BASALT BELOW. IT SEEMS UNLIKELY THAT THERE IS A SUBLOESS, PRELOESS TILL UNDER THESE HILLS, THO THERE MAY BE.

THESE PALOUSE HILLS FROM HITE TO REARDON ARE SPRINKLED WITH GRANITE AND QTZITE BLDRS. IN SOME PLACES, THERE APPEAR TO BE "NESTS" OF THEM. THEY LIE ON HILLTOPS AS WELL AS SLOPES, THE HIGHEST MEASURED BEING 60 FT ABOVE REARDON RR STATION, OR 2560 A.T. THEY REST ON LOESS AND THERE IS NO GRAVEL OR SAND OR OTHER FOREIGN MATERIAL IN THE LOESS. NOR ARE THE LOESS HILL OUTLINES ANYTHING ELSE THAN TYPICALLY MATURE. NO GLACIAL ICE EVER GOT OVER ONTO THESE HILLS. THE BLDRS. THEREFORE MUST HAVE BEEN CARRIED BY BERGS BACK INTO LOCAL LAKES IN THESE PALOUSE HILLS MINOR VALLEYS, EACH ONE DAMMED BY THE SPOKANE ICESHEET WHICH WRAPPED AROUND THIS NORTHERN SALIENT OF THE PALOUSE TOPOGRAPHY.

SCABLAND ~~XXXXXX~~ ABOUT REARDON. PALOUSE HILLS GONE. BASALT PLAIN. SOME SMALL LAKES IN ROCK BASINS, THE WATER WHICH PRODUCED THIS SCABLAND ENTERED FROM THE NORTH. REARDON IS APPROXIMATELY ON THE FORMER DIVIDE BETWEEN CRAB CREEK AND SPOKANE RIVER AND THE SCABLAND DOES NOT EXTEND MUCH MORE THAN A MILE NORTH, THO THE GLACIAL DRAINAGE LINE ACROSS MATURE TOPOGRAPHY BEGINS ABOUT FIVE MILES NORTH. THERE IS A PROMINENT CANYON IN BASALT IN THIS DRAINAGE LINE, BUT IT DRAINS NORTH AND IS OF PRE-SPOKANE AGE. GRAVEL BARS A MILE TO TWO MILES NORTH OF REARDON. A PIT IN ONE OF THEM, A MILE NORTH OF TOWN, SHOWS FORESET BEDDING WITH NORTHWARD DIP. BUT CLEARLY GLACIAL WATERS DEPOSITED IT AND ORIENTATION IN OPPOSITE DIRECTION TO COURSE OF THE GLACIAL STREAM MUST MEAN A BAR BUILT IN AN EDDY.

CRESCENT IS ON THE GLACIATED PLAIN. NO TILL, NO MORAINE OF IDENTIFIABLE CHARACTER, BUT THE THIN SOIL IN PLACES, EVEN BARE BASALT, AND THE ABSENCE OF THE MATURE HILLS OF LOESS AND RESIDUAL BASALT——— ALL INDICATE THAT THIS BASALT PLAIN IS OF THE SAME GENESIS AS FOUR MOUND, INDIAN AND SUNSET PRAIRIES. FURTHERMORE, THE FORCING SOUTHWARD PAST REARDON OF A LARGE STREAM CARRYING GRANITE FRAGMENTS IN FLOATING ICE CAN BE EXPLAINED IN NO OTHER WAY.

THE GRANITE AND OTHER ERRATIC BLDRS STRANDED AMONG THE HILLS BETWEEN HITE AND REARDON MEAN AN ICE DAM ON THE HITE SIDE OF THE PALOUSE HILLS, CLEARLY. BUT THEY REQUIRE ANOTHER EXPLANATION FOR THOSE ON THE SLOPES TO REARDON. PROBABLY THEY FLOATED IN DURING THE EARLIEST STAGES OF THE INVASION OF GLACIAL WATERS, BEFORE THE DIVIDE HAS BEEN ERODED MUCH AND THE PRESENT LOW SCABLAND CHANNEL PRODUCED.

TWO MILES WEST OF CRESCENT, THE CANYON IN BASALT IS AN IMPRESSIVE FEATURE. IT IS 1000 TO 1500 FT DEEP AND IS CLEARLY A REJUVENATED VALLEY IN THE FLOOR OF A MUCH OLDER VALLEY. THE MATURE DRAINAGE SYSTEM OF THE PALOUSE HILLS TO THE SOUTH, IS ADJUSTED TO THE OLD VALLEY FLOOR AND HAS NOT YET PARTICIPATED IN THE REJUVENATION. THIS MATURE TOPOGRAPHY DATES BACK TO PRE-PLATEAU DAYS. SPOKANE RIVER VALLEY COULDNT HAVE HAD ITS PRESENT DEPTH, NOR COULD THE COLUMBIA. IF THE LOESS MANTLE IS OF PLEISTOCENE AGE, THEN THE MATURE TOPOGRAPHY WHICH IT BEARS IS OF LATER PLEISTOCENE AGE AND THE UPLIFT OF THE NORTHERN PART OF THE PLATEAU IS OF STILL LATER PLEISTOCENE. AGE, THO PRESUMBALY PRE-SPOKANE, IF GRAND COULEE IS A SPOKANE FEATURE, THE PLATEAU AND THE BADGER MTN. FOLD MUST HAVE BEEN THERE AT THE BEGINNING OF THE SPOKANE EPOCH. THERE SHOULD BE SOME EVIDENCE OF THE UPLIFT OF THE MATURE TOPOGRAPHY ON THE FOLDS OF THE WESTERN PART OF THE PLATEAU.

THE BASALT PLAIN ABOUT CRESCENT AND NORTH OF MONDOVI IS MORE DISSECTED THAN IS SUNSET-INDIAN-FOUR MOUND. AND THE DISSECTION APPEARS TO DATE AS FAR BACK AS THE DEVELOPMENT OF THE MATURE TOPOGRAPHY THO THE REJUVENATED CANYONS ARE THE DOMINANT FEATURES.

ABOUT FOUR MILES NORTH OF MONDOVI IS AN UNGLACIATED HILL 2 OR 3 MILES LONG (N-S), WITH DEEP, BLACK SOIL, NO ERRATICS, NO ROCK FRAGMENTS OF ANY KIND. IT IS A STEPTOE HILL, HOWEVER, AS ITS ALTITUDE ABOVE THE GENERAL REGION SHOWS. SPOKANE ICE SEEMS TO HAVE WRAPPED AROUND IT, AND CLEARLY GOT TWO MILES SOUTH OF IT.

AT THE SOUTH END OF THE STEEL ARCH BRIDGE, THREE MILES BY ROAD NORTHEAST OF MONDOVI, IS TILL IN A ROAD CUT. THO THE MATRIX IS COMPOSED OF MUCH DECAYED MATERIAL AND THERE ARE MANY PEBBLES OF DECAYED BASALT IN IT, THERE ARE ALSO MANY FRESH-LOOKING FEMAG. AND FLDSPATHIC PEBBLES AND COBBLES. NO DOUBT AS TO ITS BEING GLACIAL TILL, THO NO STRIATED FRAGMENTS WERE FOUND. ~~UN~~ UNGLACIATED PALOUSE HILLS IMMEDIATELY SOUTH.

ANOTHER GLACIAL DRAINAGE CHANNEL HEADS NORTH OF MONDOVI AND IS TRACEABLE BY ERRATIC GRANITE BLDRS, CHARACTER OF VALLEY, AND SCABROCK ON FLOOR IN PLACES, TO DAVENPORT. BUSINESS PART OF DAVENPORT IS BUILT ON THE SCABLAND OF THIS CHANNEL FLOOR.

PROBABLY NO SPOKANE ICE AT LORENE, NORTH OF DAVENPORT. WHAT WAS TAKEN FOR GLACIATED BASALT PLAIN IS A CHANNEL FLOOR. PALOUSE HILLS TO THE NORTH ON MAIN HIGHWAY FOR AT LEAST 4 MILES. ROADCUTS 10 FT DEEP REVEAL DECOMPOSED GRANITE IN SOME PLACES AND A DARK BROWNISH CLAY, PROBABLY DECOMPOSED BASALT, IN MOST. LOESS ALSO. NO ERRATICS AT ALL AMONG THESE HILLS. ONLY THING WHICH SUGGESTED GLACIATION WAS A DEPOSIT OF UNASSORTED MATERIAL HALF A MILE NORTH OF LORENE LOW ON THE HILLSLOPE. FIRST TAKEN FOR TILL BUT AFTER SECTIONS FOR 4 MILES NORTH WERE SEEN, CONCLUDED THAT IT MUST BE A POORLY SORTED GRAVEL ALONG THE EDGE OF THE DRAINAGE CHANNEL.

SEVERAL CHANNELS CROSS THESE HILLS NORTH OF LORENE, FROM NE TO SW ARROXIMATELY. SCABLAND FLOORS AND STEEPENED SLOPES IN LOESS-RESIDUAL SOIL. ALSO A NUMBER OF CHANNELS, SOME POORLY DEFINED, ACROSS THE PALOUSE HILLS ABOUT FOUR MILES NORTHWEST OF DAVENPORT, LEADING TO LARGE SCABLAND AREA NORTH OF ROCKLYN. MANY WITHOUT SCABROCK FLOOR.

ON THE ROAD TO EGYPT AND LINCOLN, A FEW HUNDRED FEET FROM THE DIVERGENCE OF THE ROAD TO DETILLION BRIDGE, IS AN EXPOSURE OF GLACIAL DRIFT. IT CONTAINS A GREAT VARIETY OF ROCKS, AMONG THEM A STRIKING ~~PURPLE~~ BORDERITIC GRANITE NOT PREVIOUSLY SEEN ON THE BASALT PLATEAU. A NICELY BEVELED AND FAINTLY STRIATED PEBBLE FOUND. NO DOUBT AS TO ITS HAVING SUFFERED GLACIAL ABRASION. THIS LOCALITY IS NORTH OF ALL PALOUSE HILLS, THE REGION BEING A BASALT PLAIN WITH MANY SMALL AND SOME LARGE HILLS OF GRANITE. GRANITE DEEPLY DECAYED. HENCE SPOKANE ICE DID NOT GET FAR TO THE SOUTH, A CONCLUSION SUPPORTED BY THE PRESENCE OF THE UNGLACIATED PALOUSE HILLS NOT MORE THAN A MILE SOUTH OF THE EXPOSURE.

SPOKANE RIVER 1350 BELOW BASALT PLAIN. SPOKANE V.T. 300 FT ABOVE RIVER. STRATIFIED FLUVIOGLACIAL SAND AND GRAVEL (FINE) AS MUCH AS 200 FT HIGHER BUT ALL DISSECTED BY GULLIES. NO TERRACES ABOVE THE V.T.

DETILLION BRIDGE TO HUNTERS AUG 4

WISCONSIN MORAINE, VERY PROMINENT AT TOP OF NORTHERN BLUFFS HERE.. STEEP, RUGGED, HIGH, IRREGULAR, MANY LAKELETS, LARGE BLORS. COLOR OF MATERIAL LIGHT GRAY, STRIKINGLY DIFFERENT FROM COLORS OF ALL SURFICIAL DEPOSITS ON THE PLATEAU.

HUNTERS TO SPRINGDALE AUG 5

WISCONSIN TILL AND SOME MORAINE TOPOGRAPHY A FEW MILES EAST OF HUNTERS. NOT UPON SLOPES OF MT. RANGE BETWEEN COLUMBIA AND COLVILLE VALLEYS. THESE MTS. SHOW NO TRACE OF GLACIATION EITHER IN ROAD CUTS, IN TOPOGRAPHY OR ON THE HIGHER PARTS (COPPER BUTTE WAS CLIMBED) CAMAS BUTTE OF WEAVER IS THE NORTHERN EXTREMITY IN COLVILLE VALLEY OF THE COLUMBIA BASALT.

THE COLUMBIA BASALT.

POURED OUT TO A THICKNESS OR DEPTH IN PLACES OF 4000 FEET. SUBAERIAL IN ALL FLOWS. YET THE CANYON CUTTING EPOCH CAME LATE, AFTER MATURE TOPOGRAPHY OF PALOUSE COUNTRY (DEVELOPED IN LOESS AND BASALT) WAS PRODUCED. HENCE THE REGION MUST HAVE STOOD LOW FOR A LONG TIME, SAY ALL THE SUBSEQUENT TERTIARY AND THE EARLY PLEISTOCENE. IT MUST HAVE SUBSIDED AS THE FLOWS WERE POURED OUT.

THE ONLY POSSIBLE ALTERNATIVE IS TO HAVE THE CANYONS CUT EARLY, THEN FILLED WITH ALLUVIAL MATERIAL DUE TO SUBSIDENCE, ANC TO STAND FOR THE TIME FOR DEVELOPMENT OF MATURITY WITH THESE VALLEYS FILLED. THIS SEEMS IMPROBABLE AND HAS NO FIELD EVIDENCE TO SUPPORT IT.

SPRINGDALE TO SPOKANE AUG. 6

WISCONSIN TERMINAL MORAINE 40-60 FT HIGH AND A HALF MILE WIDE WEST OF SPRINGDALE. DOWN IN THE VALLEY. TYPICALLY MOUNDED BUT ITS RUGGEDNESS NOT PRONOUNCED. GRAY COLOR TO THE DUST AND ROCK FLOUR, ONLY THE VERY UPPERMOST PART, (2 FT OR SO) IS SLIGHTLY RUSTY IN COLOR.

LOON LAKE BEYOND THE LIMITS OF THE WISCONSIN T.M. DEEPLY DECAYED GRANITE IN ROAD CUTS. ALL INCOHERENT MATERIALE ROCK EXCEPT THE PEGMATITE DIKES IN IT. CURIOUS THAT SPOKANE ICE DIDNT REMOVE IT. STILL MORE REMARKABLE THAT IT SHOULD BE THE PRODUCT OF POST-SPOKANE WEATHERING. SECOND HYPOTHESIS SEEMS ALMOST UNTENABLE.

DEER PARK AND ENVIRONS ON SURFACE OF CAMAS (COLUMBIA) BASALT, 2100-2200 A.T. SHALLOW MATURE VALLEYS. SURROUNDED BY RUGGED HILLS OF OLDER ROCK. A LONG TONGUE WHICH PUSHED NORTHWARD FROM AREA OF MAIN FLOODING BY BASALT.

LIDGERWOOD TERRACE IN SPOKANE OUTWASH. NORTH OF DARTFORD ARE OTHER DEPOSITS OF THE SAME ORIGIN AND AGE. ALTITUDE ABOUT THE SAME. SOME LARGE GRANITE BLDRS.

LITTLE SPOKANE V.T. OF WISCONSIN AGE COMES IN ALONG EAST SIDE OF THIS SPOKANE OUTWASH NORTH OF DARTFORD AND AT THIS TOWN, CROSSES THE SPOKANE FEATURE AND JOINS THE SPOKANE VALLEY NORTH OF FIVE MILE PRAIRIE AND OPPOSITE THE MOUTH OF DEEP CREEK. THE DIFFERENCE IN ALTITUDE IS ABT. 200 FT.

THE MAXIMUM DISSECTION OF THE WISCONSIN V.T. IS THE 70 FOOT DIFFERENCE BETWEEN THE BARS WHICH DAM THE LAKES IMMEDIATELY EAST OF SPOKANE, AND THE MAIN SURFACE. AND THIS WAS DONE BY THE LATER WISCONSIN WATERS. Was this dissection, or original difference in deposition?

GRANITE LAKE AND MEDICAL LAKE AUG. 7

THE PRE-BASALT ROCK HERE IS BOTH GRANITE AND A PEPPER-AND-SALT PHANERITE WHICH CUTS THE GRANITE. THIS P-AND-S ROCK, PROBABLY DIORITE, BROT UP FRAGMENTS OF AN ARGILLITIC SEDIMENT, THE FRAGMENTS INDICATING THAT THIS SEDIMENTARY WAS CONTORTED AND METAMORPHOSED BEFORE THE P-AND-S WAS INTRUDED. THE BASALT CUTS ALL OF THESE. NO CONTACT METAMORPHISM WITH BASALT. P-AND-S CONTAINS FRAGMENTS OF GRANITE, ALSO.

BIG HILL WEST OF WEST MEDICAL LAKE, SEC 23, SOUTHERN HALF, IS ALL QTZITE. WHITE IN COLOR. STRIKE NOT FAR FROM N-S. STANDS NEARLY VERTICAL. NO TAIL OF DRIFT ON THIS HILL, EXCEPT A LOW ONE, A BAR OF SPOKANE GRAVEL. THE PROFILE WITH STEEP SLOPE TO THE NORTH AND GENTLE TO THE SOUTH IS NOT OF GLACIAL ORIGIN. STEEP TO NORTH CANNOT BE ASCRIBED TO UNDERCUTTING BY SPOKANE ICE OR WATER FOR IT IS CONSIDERABLY ABOVE THE LEVEL AFFECTED BY ICE OR WATER AND HAS UNMODIFIED TYPICAL PALOUSE HILLS TO THE NORTH (THO PROBABLY THEMSELVES DEVELOPED IN PRE-BASALT ROCK) NO PALOUSE LOESSIAL SOIL ON THIS HILL.

NO GLACIAL TILL ALONG EITHER OF THE TWO SPRAGUE ROADS WEST OUT OF CHENEY.

LAMONT AUGUST 8 1923

SP AND S CUT. ONE MILE SOUTH OF THE STATION. THE SUPPOSED TILL, SEEN EARLIER FROM THE TRAIN, IS PROBABLY SPOKANE GRAVEL, POORLY SORTED. THERE IS CLEARLY A SCABLAND PROFILE OF THE BASALT BENEATH THE DEPOSIT, OF WHICH FOUR PATCHES EXIST IN A QUARTER OF A MILE. AND THE BASALT SURFACE, THO WORN, ISNT GLACIALLY MARKED.

THE MATERIAL CONTAINS SOME BLDRS OF BASALT, 4 FT IN DIAMETER, BUT THESE SEEM TO HAVE BEEN TUMBLED IN OFF THE SURROUNDING BASALT DURING DEPOSITON, RATHER THAN INTEGRAL PARTS OF THE DEPOSIT, THE MATERIAL IS COMPOSED OF ROUNDED PEBBLES AND OF WORN BUT NOT ROUNDED COBBLES AND SMALL BLDRS., ALMOST ALL OF BASALT. THREE QTZITE AND TWO GRANITE PEBBLES FOUND.

THERE IS A RUDE STRATIFICATION, SHOWN IN THE GROUPING OF LARGER FRAGMENTS NEAR BOTTOM AND SMALLER ONES NEAR TOP, AND IN PREVAILING HORIZONTAL ORIENTATION OF ELONGATE PIECES.

THE WHOLE IS STAINED A CHOCOLATE BROWN AND SOMEWHAT INDURATED WITH IRON OXIDE. MOST OF THE SMALLER BASALT PEBBLES ARE ROTTED. BUT THE BASALT BENEATH ISNT.

IT SEEMS MOST PROBABLE THAT THIS IS A SPOKANE GRAVEL DEPOSIT WHICH, BECAUSE IT LAY LOW IN THE SCABLAND AREA, AND FORMERLY HAD A LAKELET ABOVE IT (SEE DIATOMACEOUS EARTH ABOVE) HAS BEEN CONSIDERABLY ALTERED BY GROUND WATER.

LAMONT TO LANTZ TO MARENGO TO RITZVILLE AUG. 7 1923

APPROXIMATE OUTLINES OF SURVIVING PALOUSE HILLS AND SURROUNDING SCABLAND MAPT. NOTABLE FEATURES ARE

(1) LARGE NUMBER AND SHARPNESS OF OUTLINES OF MINOR GLACIAL DRAINAGE CHANNELS, MANY NOT A MILE WIDE.

(2) SHARPNESS OF SLOPES IN PALOUSE HILLS ADJOINING THE SCABLAND.

(3) PROW-LIKE NORTHEAST FACES OF THESE HILLS, CANSED BY CONVERGENCE OF TWO STEEPENED SIDES.

(4) ALMOST INVARIABLE PRESENCE OF GRAVEL BARS ON SW ENDS AND USUALLY NO ABRUPT PROW.

(5) LARGE AREAS FROM WHICH THE PALOUSE HILL TOPOGRAPHY HAS BEEN REMOVED, BUT ON WHICH NO SCAB-LAND HAS DEVELOPED. SUCH SURFACES GENERALLY COVERED WITH BASALT GRAVEL AND BLDRS. NOTABLE ONES ARE (A) EAST OF LEON AND WEST OF COW CREEK

(B) NORTH OF MARENGO AND EAST OF COW CREEK

(C) BETWEEN COW CREEK AND RITZVILLE.

SPOKANE WATERS APPARENTLY SWEPT SOUTHWARD FROM HILLCREST TOWARD BEMIS AND FLETCHER AND WASHTUCNA COULEE, THO LITTLE OR NO SCABLAND WAS DEVELOPT. COW CREEK NOT A DEEP PRE-SPOKANE VALLEY. WHERE CROSSED BETWEEN LEON AND LANTZ, THE LOWER PART OF THE VALLEY IS FULL OF KNOBS AND BUTTES, REMARKABLY SO. THE PRE-SPOKANE FLOOR MUST HAVE BEEN 75 FT HIGHER THAN THE PRESENT.

MOST CANYONED SCABLAND SEEN WAS NORTHEAST OF LANTZ. ABANDONED FALLS AND ROCK BASINS WELL EXHIBITED. 3/4 TO 4/5 TALUS ON ALMOST ALL CLIFFS.

RELIEF OF PALOUSE HILLS MATURE TOPOGRAPHY VARIES CONSIDERABLY IN DIFFERENT PARTS OF THE AREA SEEN TODAY. THIS MAY BE DUE TO (1) SHALLOWNESS OF THE ORIGINAL LOESS-AND-RESIDUUM COVER, THE BASALT BOTTOM HOLDING THE VALLEY FLOORS, OR TO (2) GREATER DISTANCE FROM ORIGINAL TRUNK VALLEYS. IT LOOKS ~~AS/THO~~ IN PLACES AS THO THE ORIGINAL LOESSIAL SURFACE HAD BEEN UNDULATING, DEEPER IN SOME PLACES THAN IN OTHERS.

THE COLUMBIA BASALT.

IF THE PRE-BASALT TOPOGRAPHY WAS MOUNTAINOUS TO THE NORTH AND THE EAST, AND IF MOUNTAIN TOPS PROJECT THRU IT IN MANY PLACES 10-20-30 MILES OUT IN THE BASALT, AND IF SOME CANYONS, LIKE THE SNAKE, SHOW WHOLLY SUBMERGED MOUNTAINS BENEATH THE BASALT, IT IS LOGICAL TO THINK THAT THE WHOLE AREA WAS RUGOSE BEFORE THE BASALTIC FLOWS OCCURRED. WHY THEN DO NOT MOUNTAIN TOPS PROJECT ALL OVER THE PLATEAU!?? ISNT IT BECAUSE THE REGION OF THE FLOWS SUBSIDED AS THE ERUPTIONS OCCURRED?

MCELROY LAKE AND S.E. OF RITZVILLE AUG. 8

LAKE LIES IN SCABLAND CHANNEL 250 FEET BELOW THE SUMMITS OF BOUNDING PALOUSE HILLS. CHANNEL CONSIDERABLY WIDER THAN THE ONE THRU RITZVILLE, AND HAS SOME STEEPENED PALOUSE HILL SLOPES, THO IN GENERAL THERE HAS BEEN BUT LITTLE WIDENING AND UNDERCUTTING OF THE LOESS HILLS. LOESS HERE IS ALL OF 50 FT DEEP, MAY BE MUCH DEEPER. TYPICAL PALOUSE HILLS MATURE TOPOGRAPHY. PUT A FEW GROUPS OF TREES HERE AND THERE AND IT WOULD PASS FOR THE PALOUSE COUNTRY ITSELF.

NOWHERE IN ALL THE PALOUSE HILLS SOUTH OF HITE AND REARDON HAS A GRANITE OR OTHER FOREIGN BLDR BEEN FOUND ON THE PALOUSE HILL SLOPES. THIS IS GOOD EVIDENCE FOR THE PRESENCE OF GLACIAL ICE AGAINST HITE AND REARDON HILL FLANKS, DAMMING THE VALLEYS AND THE ABSENCE OF SUCH ICE IN THE CHANNELLED SCABLANDS.

BOWER

THIRD OR BAUER COULEE CARRIED A TRICKLE OF GLACIAL WATER. AT OLD PROPOSED KLEMMER STATION CROSSING, EIGHT PHANERITES, MOSTLY GRANITES, WERE FOUND IN THE GRAVEL. A VERY LITTLE SCABROCK, A VERY LITTLE WIDENING AND STRAIGHTENING OF RHE VALLEY AND A LITTLE STEEPENING IN PLACES. A SMALL ~~GRADIENT~~ GRAVEL PIT ON CROSSING OF MAIN HIGHWAY AND THIS DRAINAGE LINE, WEST OF RITZVILLE.

FIRST OR ROCKY COULEE HAS A SCABLAND FLOOR A MILE WIDE AT MARCELLUS. SOME GRANITE BLDRS. SEEN. MARCELLUS IS ALMOST AT THE HEAD OF THIS SCABLAND TRACT. EAST OF IT, THE PALOUSE HILLS ARE GONE BUT THERE IS NOT CHANNEL OR BARE ROCK. AND A WIDE LOWER TRACT TO THE NORTHEAST, DRAINED BY LAKE CREEK, ALL SCABLAND APPARENTLY.

LAKE CREEK WHERE CROST BETWEEN MARCELLUS AND DOWNS IS A BROAD CANYON IN BASALT. 100-150 FEET DEEP. IN STRIKING CONTRAST WITH IT IS CRAB CREEK VALLEY AT AND ABOVE JUNCTION WITH LAKE CREEK. THIS VALLEY IS NO LARGER NOR MORE SCABBY THAN FIRST COULEE.

NO STEEP BLUFFS OF PALOUSE HILLS BORDERING EITHER LAKE CREEK OR CRAB CREEK VALLEY HERE. INSTEAD, THE RELATIONS SUGGEST THAT THE FLOODS DID NOT SPREAD OUT OVER A WIDER BASALT FLOOR THAN EXISTED BEFORE THE SPOKANE GLACIATION.

IT IS SURPRISING TO FIND THAT GLACIAL WATERS SPILLED OVER PAST RITZVILLE ^ and down, MCELROY LAKE, THIRD AND FIRST COULEES. IT SEEMS DIFFICULT TO GET THE WATERS HIGH ENOUGH AT THE NORTH WITHOUT PUTTING GLACIAL ICE AGAINST THE HILLS SOUTH OF THE GNRR. THO GLACIAL ICE NEVER GOT ANYWHERE NEAR THESE HILLS. ISNT THE DIFFICULTY SOLVED BY RESTORING THE PALOUSE HILLS IN THE LAMONT-LANTZ-MARENGO GENERAL SCABLAND? AND IF SO (ALTITUDES WILL TELL) ISNT THE EXISTENCE OF THESE CHANNELS ABOUT RITZVILLE AND MARCELLUS PROOF THAT THERE WERE NO SCABLANDS PRECEDING THE SPOKANE EPOCH?

HARRINGTON TO SPRAGUE TO EDWALL TO DAVENPORT AUG. 8

LORD CREEK APPARENTLY NEVER HAS CARRIED GLACIAL WATERS. THE OUTLINES OF THE VALLEY GIVE NO HINT AND THERE IS NO SCABLAND AND NO ROCK SHOWING ON SLOPES. YET IT HAS AN UNUSUALLY BROAD LEVEL FLOOR FOR A PALOUSE VALLEY OF ITS SIZE, AND IN ONE PLACE (NEAR OLD CRAB CREEK P.O.) THERE IS A GRAVEL PIT IN THE FLOOR. NOT EXAMINED FOR ERRATIC MATERIAL, AS IT SHOULD HAVE BEEN. IF THIS VALLEY DID CARRY SPOKANE WATER, THE QUANTITY WAS SMALL IN VOLUME AND THE PLACE WHERE THE WATER ENTERED IT IS UNKNOWN.

A PLEXUS OF SMALL CHANNELS AND ISOLATED PALOUSE HILLS NORTH OF SPRAGUE.

WHETHER OR NOT GLACIAL WATERS WENT THRU THE VALLEY AT EDWALL IS YET A QUESTION. A FEW BASALT LEDGES AT THE BOTTOM OF THE VALLEY AND A FEW STEEPENED SLOPES. PROBABLY SHOULD BE MAPT AS A MINOR SPILLWAY.

THE REARDON SCABLAND CHANNEL BETWEEN EDWALL AND GRAVELLE IS A VERY STRIKING VALLEY. LARGELY CONFINED WITHIN LIMITS OF A PRE-SPOKANE VALLEY, 200-250 FT DEEP. THO THERE IS NOT MUCH IN THE WAY OF STEEPENED SLOPES, THE FLOOR BEARS MUCH SCABROCK AND THE VALLEY IS WIDE AND FAIRLY STRAIGHT, CLEANED OUT OF PROJECTING SPURS CLOSE TO THE OLD FLOODPLAIN.

NORTH OF DAVENPORT, THE LIMITS REACHED BY THE SPOKANE ICE SHEET ARE VERY DIFFICULT TO DETERMINE. THERE IS A BASALT PLAIN TO THE NORTH OF THE PALOUSE HILLS AND THE HIGHER GRANITE HILLS. THE PLAIN IS DEEPLY DISSECTED BY CANYONS IN BASALT, DRAINING TO SPOKANE RIVER. ONLY THE ABSENCE OF PALOUSE HILLS AND LOESS, AND THE PRESENCE OF GRANITE ERRATICS, AND THE FORMER FUNCTIONING OF THE DRAINAGE CHANNELS AT LORENE, MONDOVI AND DAVENPORT INDICATE THAT AN ICE SHEET COVERED THIS PLAIN.

DAVENPORT TO HARRINGTON TO ODESSA TO WILBUR AUGUST 9 1923

A SMALL SPILLWAY LEADS DIRECTLY SOUTH FROM DAVENPORT TOWARD BLUESTEM. NO SCABROCK OR GRAVEL SEEN FOR THE TWO MILES EXAMINED, BUT APPARENTLY SCABROCK ABOUT 1 1/2 MILES FARTHER SOUTH. JOINS OR IS CONNECTED WITH THE BROAD SCABLAND SW OF DAVENPORT AND SOUTH OF ROCKLYN.

LITTLE SCABROCK ALONG NORTH CENTRAL HIGHWAY SOUTH OUT OF DAVENPORT, THO BASALT IS JUST BENEATH THE SURFACE. SEMI-SCAB, THIS MIGHT BE CALLED. TWO MILES NORTH OF BLUESTEM, THE WIDE AREA SPLITS INTO AT LEAST FOUR CHANNELS, ALL WITH SCABROCK FLOORS. THREE LEAD TO HARRINGTON VIA THE CANYONED CHANNEL, AND ONE TOWARD BLUESTEM AND DOUBTLESS TO THE REARDON ROUTE WHERE CROSSED BY THE GNRR. THE THREE TOWARD HARRINGTON ALL CONVERGE INTO ONE ABOUT THREE MILES NORTH OF THE TOWN.

A SPLENDID SECTION IN A PALOUSE HILL 1 1/2 MILES NORTH OF HARRINGTON. THE GLACIAL RIVER CUT OFF THE NOSE OF THE HILL AND THE G.N. RECENTLY IMPROVED THE CUT. THE SECTION EXPOSES LOESS ONLY AND IT IS 48 FEET FROM TOP TO BOTTOM ABOUT 25 FEET BELOW THE RR GRADE IS THE ROADWAY. THE SECTION HERE IS OBSCURED BUT ONLY LOESS SHOWING IN THE FEW SCARS. THIS MAY, HOWEVER, BE SLUMP MATERIAL. TOP OF BASALT, SO FAR AS SHOWN IN THE CHANNEL IS LOWER THAN ROADWAY.

THE LOESS IS STRATIFIED THRUOUT. WHEN SEEN, A RECENT RAIN HAD WET THE FACE AND A NUMBER OF DIFFERENT REDDENED ZONES WERE EASILY VISIBLE. THESE ARE TAKEN TO BE OLD SURFACES, OXIDIZED DURING THE ACCUMULATION OF THE LOESS. ROOTLET MARKS, FINE ENOUGH AND ABUNDANT ENOUGH TO HAVE BEEN GRASS ROOTS, ARE COMMON. INDEED, THE MATERIAL IS FULL OF THEM. NOT A SQUARE FOOT THAT DOESNT SHOW FROM SEVERAL TO PERHAPS A HUNDRED. MARKINGS ARE RECORDED IN CACO3

MUCH LIME DEPOSITED ALSO IN STRATIFICATION PLANES. SOME HORIZONS PARTIALLY INDURATED BECAUSE OF THE ABUNDANCE OF THE LIME.

AT ODESSA THERE ARE INTERESTING RELATIONS BETWEEN SCABLAND, CANYONS, PALOUSE TOPOGRAPHY AND GRAVEL DEPOSITS. A HUGE GRAVEL BAR, THREE MILES OR SO IN LENGTH, DEPENDS FROM THE ANGLE BETWEEN LAKE AND CRAB CREEKS. IT MUST BE NEARLY 100 FT ABOVE THE VALLEY FLOORS. THRU IT PROJECT SEVERAL BIG BASALT KNOBS AND BUTTES, THE RELICS OF THE PRE-SPOKANE SHOULDER AT THE JCT. OF LAKE AND CRAB CREEK VALLEYS.

AT THE SAME LEVEL IS AN EXTENSIVE VALLEY FILL IN THE LOWER FEW MILES OF DUCK CREEK VALLEY. ITS DISSECTION IS BUT SLIGHT. IT LOOKS LIKE THE SURFACE OF THE ADRIAN GRAVEL TERRACE WHICH LAST SUMMER WAS INTERPRETED AS WISCONSIN IN AGE. IT SEEMS QUITE POSSIBLE THAT THESE ALL BELONG TO ONE FILL, OF SPOKANE AGE, ADJUSTED TO THE LEVEL OF THE QUINCY BASIN GRAVEL FILL. PERHAPS TRIBUTARY CONTRIBUTIONS, PERHAPS SIMPLY SPARED BY POST-SPOKANE STREAM EROSION.

BOTH LAKE CREEK AND CRAB CREEK VALLEYS HERE APPEAR TO BE PRE-SPOKANE IN AGE. NEITHER HAS SCABLAND BACK FROM THE BRINK OF THE CANYON WALLS. INSTEAD, PALOUSE HILLS COME TO THE EDGE. HAD THERE BEEN NO SUCH VALLEYS, 200 FT DEEP IN THE BASALT, THE FLOODS WOULD HAVE SPREAD AS THEY DID IN THE CHENEY-SPRAGUE-LAMONT REGION, AND WOULD HAVE UNDERCUT AND REMOVED THE PALOUSE HILLS OVER A WIDE AREA. AS IT WAS, IT SEEMS CLEAR THAT FROM A SMALL SPILLWAY 3 1/2 MILES NORTH OF ODESSA THAT GLACIAL WATERS OVERRAN THE BRIMS OF THE CANYONS OF DUCK CREEK AND FOUND NEW ROUTES ACROSS PALOUSE HILL TOPOGRAPHY; NOT SUFFICIENTLY HOWEVER TO MAKE WIDE SCAB TRACTS. SINCE THESE CANYONS ARE 200 FT DEEP OR MORE, THE GLACIAL RIVERS WERE THAT DEEP TO CONTAIN THEM, OR ELSE THE CANYONS WERE PARTIALLY FILLED WITH GRAVEL AT THE VERY BEGINNING OF THE FLOOD.

THAT THE CANYONS HAD BEEN CUT TO PRESENT DEPTHS IS PRE-SPOKANE TIME SEEMS INDICATED BY SOME MINOR TRIBUTARY VALLEYS WHICH NEVER WERE INVADED BY GLACIAL STREAMS. THESE CARRY PALOUSE TOPOGRAPHY DOWN ALMOST TO THE LEVEL OF THE CANYON FLOORS———— HOLD !! THERES SOMETHING WRONG HERE!! THESE COULDNT HAVE BEEN PALOUSE TOPOGRAPHY TRIBUTARYS. FOR THE MAIN CANYONS WERE ONLY CANYONS. MUST SEE THIS COMBINATION AGAIN. (Aug 11 1923)

TRAVERSE FROM ODESSA TO WILBUR VERY INTERESTING. SCABLAND COULEES AND PALOUSE HILL MATURITY, ASSOCIATED IN NEW COMBINATIONS, BUT THE OLD RELATIONS HOLD INVARIABLY. LOESS NOT AS DEEP HERE AS IN DAVENPORT-LAMONT-LANTZ REGION. VALLEYS IN THE MATURE TOPOGRAPHY NOT AS CLOSELY SPACED, AND PERHAPS NOT AS DEEP. STRUCTURE ALSO CONTROLS HERE IN SOME MEASURE. A BROAD UPWARD TRENDS E-W ABOUT 8 MILES SOUTH OF WILBUR. IT IS NOT CONSPICOOUSLY HIGH BUT FROM ITS CREST, MUCH BROADER VIEWS CAN BE OBTAINED THAN FROM ORDINARY PALOUSE HOLL SUMMITS ON THE TRAVERSE. FROM IT, THE EASTWARD EXTENSION OF THE GRAND COULEE MONOCLINAL UPWARP CAN BE SEEN NORTH OF THE RR. BETWEEN THE TWO LIES A BROAD LOWER LAND, IN WHICH LIES THE RR, THE TOWNS OF WILBUR, GOWAN AND ALMIRA AND THE CREEK WHICH DRAINS WESTWARD. THIS FLAT CONTAINS SCABLAND AT THE TWIN LAKES 8 MILES SOUTH OF WILBUR AND GRAVEL WHICH LOOKS LIKE A DELTA TERRACE NEARER WILBUR. IT APPEARS TO BE AN EASTWARD EXTENSION OF THE HARTLINE GRAVEL PLAIN.

SCABLAND INVARIABLES.

1- SCABLAND INVARIABLY ON OR IN BASALT
2- SCABLAND INVARIABLY ELONGATE WITH DIP SLOPE OF BASALT
3- SCABLAND INVARIABLY HAS CONTINUOUS GRADIENT
4- SCABLAND INVARIABLY COINCIDES WITH, OR DEVELOPED IN, PRE-EXISTING DRAINAGE LINES
5- SCABLAND INVARIABLY TRACEABLE UPGRADIENT TO THE GLACIATED AREA, BUT NOT ON IT.
6- SCABLAND INVARIABLY BEARS DISCONTINUOUS STREAM GRAVEL, IN TERRACES OR BARS
7- SCABLAND INVARIABLY BEARS BOULDERS OF FOREIGN ROCK, GRANITE, QTZITE, ETC.
8- SCABLAND WITH STEEP GRADIENT INVARIABLY NARROW.
GENTLE GRADIENT INVARIABLY WIDE
9- SCABLAND INVARIABLY WITHOUT MANTLE OF DECAYED MATERIAL
10- SCABLAND INVARIABLY FLANKED BY MATURE TOPOGRAPHY
11- SCABLAND TRACTS INVARIABLY CONNECTED
12- SCABLAND TRACTS INVARIABLY WITH ROCK BASINS
13- SCABLAND TRACTS INVARIABLY LOWER THAN ADJACENT NON-SCABLAND
14- NO CHANNELLED SCABLAND SOUTH OF SNAKE RIVER, OR WEST OR NORTH OF THE COLUMBIA RIVER
7A- PROPORTION OF FOREIGN DEBRIS ON SCABLANDS INVARIABLY SMALLER WITH INCREASING DISTANCE DOWN GRADIENT.

6A- GRAVELS INVARIABLY REST ON A SCABLAND BASE.
6B- GRAVELS IN BARS IN PROTECTED SITUATIONS. NOT FRAGMENTS OF ONCE CONTINUOUS TERRACE FILLINGS
10A- SCABLAND OPENINGS ON TO BASALT PLAIN TO THE NORTH OR INTO COLUMBIA OR SNAKE RIVERS TO S & W.

PALOUSE HILLS INVARIABLES

1- MATURE, DENDRITIC, IN MINOR VALLEYS
2- LOESS
3- WHERE SURROUNDED OR BOUNDED BY BROAD SCABLAND TRACTS, ALWAYS WITH STEEPENED SLOPES AT CONTACT.

4– AS IN (3), ALWAYS WITH PROWS POINTING UP THE GRADIENT OF THE SCABLAND

5– WHERE VALLEYS DRAIN TOWARD AND TO THE GLACIATED TRACT, ALWAYS BEAR ERRATIC BLDRS

6– TRACTS ALWAYS SEPARATED BY SCABLANDS.

VICINITY OF CRESTON AUG 10 1923

A GROUP OF PALOUSE HILLS 7–8 MILES NORTH OF TELFORD. NO ROCK FRAGMENTS OF ANY KIND FOUND ON THEIR SLOPES. DARK PALOUSE LOESSIAL SOIL. ABOUT 100 FEET ABOVE THE BASALT PLAIN TO THE WEST AND TO THE SOUTH. HAWK CREEK TRIBUTARY CANYONS TO THE NORTH. MORE HILLS OF THIS SORT TO THE EAST. CLEARLY UNGLACIATED. BUT CUT BY CHANNELS OF GLACIAL WATERS WHICH SCOURED DOWN TO BASALT AND TO SOME EXTENT, STEEPENED THEIR NORTHERN, EASTERN AND WESTERN SLOPES. THE FACT THAT THE GLACIAL WATERS WENT THRU THE GROUP FROM THE NORTH, THO THE AREA IMMEDIATELY NORTH DROPS OFF IN THE CANYONS OF THE HAWK CREEK TRIBUTARIES, PROVES THAT GLACIAL ICE CROWDED UP AGAINST THESE HILLS. BUT THERE IS NOT MORE TRACE OF MORAINIC TOPOGRAPHY HERE THAN ON SUNSET PRAIRIE AND AGAINST THE HILLS NORTH OF HITE. NEITHER ARE THERE BERG–DRIFTED ERRATICS ON THESE HILLS. THIS IS CLEARLY BECAUSE THE GROUP IS SMALL AND NO VALLEYS OF IMPORTANCE ARE ENCLOSED AMONG THEM.

ABOUT TELFORD BOTH NORTH AND SOUTH AND EXTENDING NORTH TO THESE HILLS IS A SCABLAND PLAIN WITHOUT CANYONS AND WITHOUT MUCH RELIEF, THO IT IS ROUGH. SUCH A PLAIN COULD HARDLY HAVE BEEN FORMED BY GLACIAL ICE, YET IT ISNT DISTINCTIVELY THE WORK OF GLACIAL WATERS. WERE IT NOT FOR ITS SETTING, WITH PALOUSE HILLS UNGLACIATED TO THE NORTH, IT MIGHT DOUBTFULLY BE REFERRED TO AS A PRODUCT OF GLACIATION.

THE FIELD RELATIONS, HOWEVER, SHOW THAT GLACIAL ICE NEVER REACHED IT, AND THE BGSA MAP MUST BE REVISED HERE ALSO. SOUTH OF THE RR ARE SEVERAL SURVIVING PALOUSE HILLS, STEEPENED ON EAST AND WEST, WITH NORTHWARD PROWS, AND SEPARATED BY SCABLAND WITH CANYONS AND LAKES. STILL FARTHER SOUTH IS A GREAT AREA WITH ONLY SCABLAND AND GRAVEL BARS. FROM THIS LARGE AREA CAME THE WILLOW CREEK GLACIAL WATERS, THE CON–NA–WAI GLACIAL WATERS, THE LAKE CREEK AND DUCK CREEK GLACIAL DRAINAGE. PROBABLY THIS BROAD SCABLAND AREA IS A PART OF THE SCABLAND TRACT WEST OF DAVENPORT. ALL OF THE FAMILIAR "INVARIABLE" RELATIONS OF SCABLANDS ANC PALOUSE HILLS ARE FOUND HERE.

THE BROAD UPWARP NOTED IN AUG. 9 NOTES DETERMINES THE NOSE BETWEEN CON–NA–WAI AND WILLOW CREEK SCABLAND TRACTS.

NORTH OF WILBUR AND CRESTON AUG 10

PALOUSE TOPOGRAPHY TO BRINK OF COLUMBIA VALLEY NORTH OF WILBUR AND AS FAR EAST AS THE LONGITUDE OF CRESTON. BASALT PLAIN EAST OF THIS LONGITUDE WITH A FEW ELONGATE PALOUSE HILLS NOT ACCURATELY LOCATED, ONLY SKETCHED IN THE MAP. THIS PLAIN AND ITS INCISING CANYONS, 4–5 MILES NORTH OF CRESTON, BEARS ABUNDANT GLACIAL ERRATICS. BUT THE HILLS FORBID GLACIAL ICE AND THIS MUST BE MAPT AS SCABLAND BY GLACIAL DRAINAGE. WILBUR GOT ITS GLACIAL WATERS FROM CRESTON.

CRESTON TO ODESSA AUG 11

SCABLAND AT WILBUR PRODUCED BY DRAINAGE FROM CRESTON, NOT FROM THE NORTH. A PRE-SPOKANE DIVIDE HERE AT THE NORTH, AND A DIVIDE HERE TODAY. WATERS USED AT LEAST THREE SPILLWAYS ACROSS THE DIVIDE, THE NORTHEN ONE OF WHICH WAS ERODED TO BASALT AND A SCABROCK FLOOR DEVELOPED.

AN ENORMOUS SCABLAND AREA SW OF TELFORD, 20 MILES FROM THE ARROXIMATE EDGE OF THE ICE TO ITS CONVERGENCE INTO DEFINITE SPILLWAYS AND 13 MILES WIDE. NOT MORE THAN A DOZEN ISOLATED PALOUSE HILLS OR HILL GROUPS. ALL SUCH SHOW THE NORTHWARD STEEPENING AND PROW SHAPE. SOME, BUT NOT ALL , OF THE MARGINS OF THE SURROUNDING HILL AREAS SHOW STEEPENING. ALL CHANNELS LEADING OFF TO THE SW SHOW STEEPENING ALONG THEIR MARGINS.

THIS SCABLAND TRACT IS NOT PLANE IN A GENERAL WAY. THERE ARE BROAD, RELATIVELY SHALLOW VALLEYS ~~VALLEYS~~ AND BROAD, RELATIVELY LOW RIDGES, ALL TRENDING TOWARD THE SW. IN THESE VALLEYS LIE THE FEW SMALL CANYONS THE AREA HAS. IT IS THOT THAT THESE VALLEYS RECORD THE PRE-SPOKANE PALOUSE MAIN VALLEYS WHICH HAD BEEN ERODED INTO BASALT AND THE RIDGES ARE THE BASES OF THE OLD PALOUSE HILLS, THE LOESS ONLY HAVING BEEN REMOVED. NONE OF THE SURVIVING ISOLATED PALOUSE HILLS SHOW BASALT LEDGES IN THE STEEPENED FACES.

THIS GREAT SCABLAND TRACT THEREFORE HAS BEEN PRODUCED LARGELY BY REMOVAL OF THE LOESS ALONE. SOME CANYONING HOWEVER, AND A GOOD DEAL OF SCRUBBING ON ALL BASALT SURFACES HAS OCCURRED, TO GIVE IT THE SCABLAND TOPOGRAPHY OF MINOR CHANNELS, ROCK BASINS, KNOBS AND LOW BUTTES.

THE WATER WHICH DID THIS MUST HAVE SPREAD AS A BROAD SHEET AND MUST HAVE BEEN DEEPER THAN THE RELIEF IN THE BASALT BENEATH THE LOESS. THIS RELIEF (NEGLECTING SPOKANE-FORMED CANYONS) IS 50 FEET IN MANY CROSS SECTIONS.

THE GRADIENT IS CONSIDERABLE FOR THE LENGTH OF THE SCABLAND BUT IS UNKNOWN. THE DIFFERENCE IN ALTITUDE BETWEEN ROCKLYN OR TELFORD ~~OR~~ AND ODESSA WILL GIVE GRADIENT FOR THE SCABLAND TRACT AND THE DUCK CREEK DRAINAGE LINE. PROBABLY THE GLACIAL WATERS DIDNT HAVE ALL THAT AT THE BEGINNING WHEN THEY SPREAD SO WIDELY, FOR THEN THE CANYONS (DUCK CR., CON-NA-WAI CR., LAKE CR.) WERE NOT AS DEEP AS NOW.

THE AMOUNT OF DEEPENING AT ODESSA BY SPOKANE WATERS IS DETERMINABLE APPROXIMATELY. THE PALOUSE VALLEYS IMMEDIATELY NORTH OF THE TOWN, UNTOUCHED BY GLACIAL STREAMS, HAVE THEIR FLOORS 200 FEET OR MORE ABOVE CRAB CREEK VALLEY BOTTOM. AND THEY ARE MATURE WITH CONCAVE SLOPES. THERE COULD HAVE BEEN NO CANYON IN CRAB CREEK VALLEY WHEN THEY WERE DEVELOPED. SINCE THESE PALOUSE HILL VALLEYS WERE DEVELOPT, THE MAIN HAS BEEN DEEPENED 200 FT BY THE SPOKANE DISCHARGE.

THIS RELATION APPARENTLY DISPOSES OF THE CONCEPTION OF A SECOND CYCLE, REJUVENATED VALLEY IN CRAB CREEK BEFORE THE SPOKANE GLACIATION. OTHERWISE, CON-NA-WAI CREEK, DUCK CREEK AND LAKE CREEK VALLEYS WOULD ALSO HAVE HAD CANYONS IN PRE-SPOKANE TIME. AND ALL FIELD EVIDENCE INDICATES THAT THESE DIDNT EXIST. HAD THEY BEEN PRESENT, NO WIDE SPREADING ON THE BIG SCABLAND TRACT WOULD HAVE BEEN POSSIBLE. (? they don't drain the tract, they head only on it to southern margin)

IN OTHER WORDS, IF THE SPOKANE ICE SHEET COULD BE RESTORED, ITS DRAINAGE WOULD NOT NOW SPREAD ALL OVER THE TRACT, NOR WOULD IT HAVE MADE SOME OF THE MINOR CHANNELS ACROSS PALOUSE HILLS, CHANNELS WHICH NEVER REACHED BASALT AND HENCE HAVE NO SCABROCK FLOOR. THE CANYON-CUTTING OCCURRED WHILE THE GLACIAL WATERS WERE BEING SUPPLIED, AND BY ITS OCCURRENCE, DREW OFF THE WATERS FROM THESE MINOR CHANNELS SO THAT THEIR GROWTH IN DEPTH AND WIDTH WAS STOPT EARLY IN THE EPOCH.

THE BIG GRAVEL FILL IN LOWER DUCK CREEK IS ABOUT 200 FT ABOVE CRAB CREEK VALLEY. IT LIES IN A CANYON. IT IS A PRODUCT OF THE GLACIAL DRAINAGE. HENCE SOME COMDITIONS CHANGED DURING THE LATTER PART OF THE EPOCH, TO CAUSE THIS AGGRADATION. WHAT ??

ODESSA TO WILSON CREEK AUG. 11 1923

NORTH CENTRAL HIGHWAY IS ON SUMMIT OF BLUFFS SOUTH OF CANYON FOR WHOLE DISTANCE. SOME SCABLAND BUT MOSTLY GRAVEL-COVERED BASALT. ALTITUDE IS 300 FT OR MORE ABOVE FLOOR OF CANYON. AND IT EXTENDS A MILE AND A HALF OR SO SOUTH OF THE CANYON. APPARENTLY NOT SO EXTENSIVE TO THE NORTH OF THE CAMYON. NEVERTHELESS, THE EVIDENCE OF A VERY WIDE SHEET OF WATER IS CONVINC-ING, A QUANTITY GREATER THAN THE PRE-SPOKANE VALLEY IN BASALT COULD CARRY.

IT APPEARS THAT WATER ESCAPED SOUTHWARD OUT OF THIS OVER-FULL VALLEY TO FLOW SOUTHWARD ACROSS TO BLACK ROCK COULEE. MUST SEE THIS IN THE FIELD (AUG 17 NOTES)

COULEE CITY TO ALMIRA TO KRUPP (MARLIN) AUG. 12 1923

FIRST TERRACE EAST OF COULEE CITY IS 110 FEET ABOVE THE TOWN. CHANNEL BACK OF IT IS 15-20 FEET DEEP. SECOND TERRACE IS 165 FEET ABOVE COULEE CITY BACK ON THE FLAT TOP. THE BOWLDERY FACE OF THIS TERRACE MAY HAVE BEEN TAKEN BY PARDEE FOR A MORAINIC ACCUMULATION, IN SUPPORT OF HIS CONTENTION THAT A TONGUE OF ICE "TRAVERSED THE COULEE ITSELF".

THE HARTLINE PLAIN IS NOT ALL GRAVEL AND SAND, DEPOSITED BY GLACIAL WATERS. IT IS BOWLDERY AND GRAVELLY NEAR THE COULEE, SANDY ABOUT 5-6 MILES EAST AND FARTHER EAST IT IS UNDERLAIN BY LOESSIAL SILT. AS AN AGGRADATIONAL FEATURE, IT DOESNT EXTEND EAST OF HARTLINE, THO THE SURFACE FOR A FEW MILES FARTHER EAST IS REMARKABLY PLANE FOR THIS REGION. EAST AND SOUTH OF HARTLINE IS THE LOESSIAL SOIL, THE SURFACE RISING MORE NOTICEABLY THAN OVER THE GRAVEL AND SAND FLAT. THIS FLAT RANGES FROM 165 TO 200 FEET ABOVE COULEE CITY, HIGHER IN THE EAST.

A FAIRLY DEFINITE CHANNEL ACROSS THE EASTERN PART, LEADING FROM GRAND COULEE AROUND THE NORTHERN MARGIN AND THEN SOUTHWARD TO DEADMAN'S GULCH. THE DRAINAGE LINES ON THE BLUEPRINT COUNTY MAP ARE ALONG THE SOUTHEAST MARGIN OF THE PLAIN.

NO GLACIAL WATERS, OR AT THE MOST, ONLY A TRICKLE, CAME ACROSS THE DIVIDE FROM WILSON CREEK TO THE HARTLINE BASIN. (LATER NOTE— NONE CAME ACROSS) 1927- Yes, some did!

MAP SHOWS SCABLANDS AND PALOUSE HILLS BETWEEN ALMIRA AND KRUPP. AT CROSSING OF TRAVERSE AND CON-NA-WAI CREEK, SOME INTERESTING RELATIONS ARE SHOWN. THE PALOUSE HILL TOPS ARE 350 FT ABOVE CANYON FLOOR. YET GLACIAL WATERS REACHED WITHIN 75 FT OF THESE SUMMITS, AS SHOWN BY SCABBY LEDGES ALONG THE MAIN VALLEY AND A FEW ERRATIC GRANITES DRIFTED IN ICE BACK IN THE UNERODED TRIBUTARY VALLEYS. THE SLOPES OF THE OLD PALOUSE VALLEY OF CON-NA-WAI CREEK, CUT IN BASALT, SHOW CLEARLY. THE CANYON HAS BEEN ERODED ONLY IN THE CENTRAL PART AND IS NOT VERY DEEP. IT LOOKS AS THO WIDENING, RATHER THAN DEEPENING, HAS DONE MOST IN MAKING THE CANYON.

KRUPP (MARLIN) TO STRATFORD TO COULEE CITY AUG. 12

SEVERAL PLACES IN CRAB CREEK VALLEY HERE HAVE PROMINENT BUTTES AND MESAS, ISOLATED OR PARTIALLY ISOLATED ON THE FLOOR OF THE CANYON. THEY ARE REMNANTS OF THE PRE-SPOKANE VALLEY FLOOR AND THEIR HEIGHT (100 FT IN PLACES) IS A MINIMAL MEASURE OF THE DEPTH OF CANYON-CUTTING BY THE SPOKANE WATERS. THEY WOULD NOT EXIST IF THIS WERE A NORMAL CANYON, CUT BY A SMALL STREAM THRU A LONG PERIOD OF TIME. NOTHING OF THIS SORT IS FOUND IN THE SECOND CYCLE, REJUVENATED CANYONS DRAINING INTO SPOKANE AND COLUMBIA RIVERS FROM THE PLATEAU, OR IN THE REJUVENATED CANYONS OF PALOUSE RIVER EAST OF THE SCABLANDS.

THE LAKES OF THESE CANYONS, LIKE CRAB, CON-NA-WAI, DUCK, WILSON, ETC., PROVE THAT STREAM EROSION HAS DONE VERY LITTLE SINCE THE SPOKANE FLOODS SUBSIDED. THE INTERPRETATION OF THE BIG GRAVEL DEPOSITS, ALREADY NOTED, AND OTHERS BETWEEN KRUPP AND STRATFORD, AS TERRACE REMNANTS LEFT BY POST-SPOKANE STREAM DISSECTION OF A ONCE CONTINUOUS FILL MUST BE DISCARDED. HOWEVER, TERRACE-LIKE IN FORM, THESE ARE EITHER BARS AND DELTAS BUILT BY TRIBS IN THE MAIN OR THEY ARE REMNANTS OF A CONTINUOUS FILL, MADE AND DISSECTED DURING THE SPOKANE EPOCH. IF THE LATTER, A REASON FOR SUCH FILL AFTER CANYON-CUTTING, AND THEN EROSION OF THE FILL, MUST BE FOUND.

IT MIGHT BE SUGGESTED THAT A MINOR RETREAT OF THE FRONT OF THE SPOKANE ICE SHEET MIGHT ALLOW DEPOSITION OF GRAVEL TO FILL THESE CANYONS COMPLETELY ACROSS AND 200 FT DEEP. THEN A RE-ADVANCE MIGHT SUPPLY WATER TO ERODE. BUT THE FATAL OBJECTION TO THIS EXPLANATION IS THE FACT THAT IF A MINOR REDUCTION IN WATER SUPPLY ALLOWED GRAVEL FILLS TO ACCUMULATE, THEN WHEN THE FINAL FAILURE CAME, THE SAME EVENT WOULD OCCUR. AND IT DID NOT !!

THE CONCEPTION OF THESE AS BARS IS MORE SATISFACTORY. THE ADRIAN TERRACE MUST THEREFORE BE GROUPED WITH THESE OTHER BARS. IT IS FAR LARGER, HOWEVER. BUT ITS SURFACE AND THAT OF THE STRATFORD TERRACE AT BIG 4 ORCHARDS, 2 MILES WEST OF STRATFORD STA., FALL INTO THE SAME PLANE.

THE BEST VIEWPOINT FROM WHICH TO SEE THE GRAND COULEE DISTRIBUTARY PLEXUS IS FROM THE PALOUSE HILL A MILE SOUTH OF BACON STATION. IT IS NEARLY A BIRD'S EYE VIEW, EXCEPT THAT THE MAIN CANYON OF GRAND COULEE ISNT VISIBLE. IT IS A DRUMHELLER CHANNELS PLEXUS OVER AGAIN. THE DISTRIBUTARY RELATIONS ARE STRIKING, AND THE SPILL OVER TO SPRING COULEE IS CLEAR, BOTH FROM THE EROSIONAL FORMS AND FROM THE PLACING OF A BIG GRAVEL BAR BEHIND A MESA BETWEEN TWO CHANNELS AND POINTING TOWARD THE HEAD OF SPRING COULEE.

BUT THE TALUS IN THESE DISTRIBUTARY CANYONS IS SPOKANE IN AGE, NOT WISCONSIN. WISCONSIN WATERS NEVER ENTERED THEM. GRAND FALLS ORIGINATED IN SPOKANE TIME AND RETREATED ENOUGH TO CUT OFF THE HEAD OF THESE DISTRIBUTARY CANYONS BEFORE THE END OF THAT EPOCH.

TWO BROAD LOW ANTICLINAL UPWARPS HERE. ONE CONSTITUTES THE UNUSUALLY HIGH PALOUSE HILL GROUP FROM WHICH THE VIEW WAS SECURED. THE OTHER LIES ABOUT 6 MILES TO THE NORTH AND ITS NORTHERN RIM IS THE SOUTHERN SCABLAND RIM OF THE HARTLINE-COULEE CITY STRUCTURAL BASIN. BOTH STRIKE NEARLY E-W DEADMAN'S GULCH, AS A GULCH OR CANYON, IS LIMITED TO THE WIDTH OF THIS NORTHERN ANTICLINE. SOUTH OF IT, THE GULCH FORM DISAPPEARS UNTIL ITS DRAINAGE ENTERS SPRING COULEE OVER THE LEDGES OF THE NORTHERN LIMB OF THE SOUTHERN ANTICLINE.

PROBLEM OF THE QUINCY BASIN GRAVELS

ALTITUDES OF THE SURFACES OF THE GRAVEL BARS WITH FLAT TOPS IN CRAB CREEK AT AND ABOVE ADRIAN MUST BE SECURED. ALTITUDES AND GRADIENTS OF THE BIG GRAVEL DEPOSITS IN THE BASIN ITSELF. DO THEY FALL INTO A HARMONIOUS STREAM GRADIENT? OR DO THESE CRAB CREEK TERRACE TOP BELONG TO THE LEVEL OF THE BIG BROAD CHANNELS CUT IN THE GREAT GRAVEL FILL? LAST SUMMER'S INTERPRETATION WAS THAT THE CHANNELS WERE THE WORK OF WISCONSIN WATER. IS THIS CORRECT?

WHAT CAUSED THE CUTTING OF THE CHANNELS IF THEY ARE OF SPOKANE ORIGIN?

WHAT ALLOWED EROSION OF THE CRAB CREEK CANYON WHICH CONTAINS THESE BARS AT AND ABOVE ADRIAN, IF CONDITIONS IN QUINCY BASIN DEMANDED DEPOSITION UPSTREAM LATER?

TRY THE HYPOTHESIS THAT THE GREAT TERRACES OF QUINCY BASIN NEVER WERE CONTINUOUS WITH EACH OTHER; THAT THEY WERE BARS DEPOSITED WHILE THE DISHAW, ROCK SPRINGS AND WILLOW CRK CHANNELS WERE RUNNING FULL AND TOO SWIFTLY FOR DEPOSITION TO OCCUR.

COULEE CITY TO OSBORN'S RANCH (N. end of Grand Coulee) AUG. 13 1923

BONES OF CAMEL, EITHER CAMELOPS OR AUCHENIA, FOUND IN WELL AT ELEASON'S RANCH, THREE MILES NORTHEAST OF COULEE CITY ON THE SUNSET HIWAY (OLD ROUTE?) 64 FT BELOW THE SURFACE. WELL IS AT FOOT OF THE BIG GRAVEL SCARP. WELL LOG

20 FT GRAVEL CEMENTED WITH REDDISH CLAY
2 FT BLACK SAND
10 FT SANDY CLAY
32 FT GRAVEL CEMENTED WITH REDDISH CLAY
8 FT BLACK SAND

BONES FOUND IN BLACK SAND. NO BEDROCK KNOWN HERE BUT LEDGES NOT FAR AWAY AT A LOWER LEVEL. GIDLEY (HAY?) THINKS AGE IS LATE PLIOCENE OR PLEISTOCENE, PREFERABLY THE FORMER BECAUSE OF STATE OF PETRIFACTION. (HAY THINKS FIRST INTERGLACIAL— PERSONAL INTERVIEW)

TERRACES OF NESPELEM SILT ALL THE WAY FROM BIG ORCHARD NEAR COULEE CITY TO HEAD OF GRAND COULEE. SURFACE OF TERRACES RISES SLIGHTLY TO THE NORTH. ONE MILE NORTH OF DRY ALKALI LAKE, 9 ~~1/2~~ MI NORTH OF LATITUDE OF COULEE CITY, SURFACE IS 50 FT LOWER THAN COULEE CITY. NORTH OF STEAMBOAT ROCK, THE SURFACE IS ABOUT THE COULEE CITY LEVEL. A SECTION PHOTOGRAPHED SHOWS CURRENT BEDDING IN THE COARSER SUMMER LAYERS, WITH SOUTHWARD DIP.

DRY ALKALI LAKE SURFACE IS 125 FT LOWER THAN COULEE CITY.

STEAMBOAT ROCK HAS A LARGE GRAVEL BAR AT ITS SOUTHERN END, 150 FT ABOVE GENERAL LEVEL OF COULEE FLOOR HERE. SOME SAND DUNES ON ITS LOWER SLOPE MAKE IT LOOK A LITTLE MORAINIC. HIGHEST POINT OF STEAMBOAT ROCK IS 800 FT ABOVE THE ROAD TO THE EAST.

STEAMBOAT ROCK HAS A VERY GOOD CHANNELLED SCABLAND SURFACE. ONE CHANNEL WHICH CROSSES THE SOUTHERN PART, AT HEAD OF THE TRAIL, IS 100 FT DEEP. OTHERS ON NORTHERN PART ARE SOMEWHAT OBSCURED BY GLACIAL DDBRIS. THE BROKEN EASTERN FACE OF THE ROCK IS BUT THE BOTTOM AND ~~EASTERN FACE~~/ WESTERN WALL OF ONE OF THESE SCABLAND CHANNELS OF THE ORIGINAL SPILL, BEFORE THE GREAT CANYONS ON EITHER SIDE WERE CUT AND THE ROCK ISOLATED.

THERE ARE THOUSANDS OF GRANITE BOULDERS ON THE ROCK. THE LARGEST ONE IS NOW BUT A PILE OF WRECKAGE, HAVING BEEN SHATTERED BY RROST INTO 10 OR 20 SMALLER PIECES. THE LARGEST INTACT BOULDER IS PERCHED ON THE VERY EDGE OF THE SOUTHERN CLIFF AND IS EASILY VISIBLE FROM THE

FLOOR OF THE COULEE. IT IS APPROXIMATELY 5 X 6 X 10 FT. BESIDES THESE BOULDERS THERE ARE MANY COBBLES AND PEBBLES OF MANY KINDS OF FOREIGN ROCK. AND, BEST EVIDENCE OF ALL, THERE IS A DEFINITE MORAINIC RIDGE, HUMMOCKY AND BOULDERY, TRENDING NNE ACROSS THE TOP OF THE ROCK. MANY MORAINIC HILLOCKS, ENCLOSING BASINS IN DRIFT, LIE NORTH OF IT. ONE OR TWO HUMMOCKS AND MANY ERRATIC BLDRS SOUTH OF IT. THE RIDGE IS 25-30 FT HIGH. HYDE REPORTED GLACIAL STRIAE ON SOUTHERN EDGE OF THE ROCK. WE FOUND ALMOST NO DRIFT OVER THIS PART, SAVE AT THE EASTERN ~~XXXXXX~~. PORTION JUST BARE ROCK AND A DOZEN ERRATIC PEBBLES. LOOKED AS THO THE ICE HADNT REACHED THAT FAR.

GRANITE KNOBS GLACIATED ON NW SIDES, EXCEPT THOSE AT MOUTH OF NORTHRUP CANYON AND ALONG EAST WALL SOUTH OF IT. FEEL SURE OF THIS NOW. NESPELEM TERRACE AT EAST SIDE OF HEAD OF GRAND COULEE IS SAME ALTITUDE AS COULEE CITY.

SCABLAND ON EAST SIDE OF UPPER GRAND COULEE SHOWS SOME RELIEF ASCRIBED TO PALOUSE HILL BASES AND VALLEYS. PALOUSE SOIL IS REDDISH LOESS BUT NOT VERY THICK. MOST OF THE RELIEF OF THE EXISTING MATURE TOPOGRAPHY EAST OF THE SCABLAND IS ERODED IN BASALT. AT LEAST TWO PALOUSE HILLS ARE ISOLATED FROM THE REST OF THE PALOUSE HILL TOPOGRAPHY IN THIS UPPER GRAND COULEE SCOURED TRACT BY SMALL LINEAR SCABLAND CHANNELS. SEEN FROM EASTERN MARGIN, THE GRAND COULEE CANYON ISNT EVEN SUGGESTED AND THE WHOLE VIEW IS IDENTICAL WITH THAT IN THE TELFORD WIDE SHALLOW-CHANNELLED SCABLAND.

HIGHEST POINT ON THE ALMIRA ROAD (COUNTY LINE) NORTH OF HARTLINE BASIN, IS 1050 ABOVE COULEE CITY. SOUTHERN SLOPE OF THE MONOCLINE HAS MUCH BARE BASALT AND SOIL TOO THIN FOR TILTH. NO LOESS ON THESE SLOPES. THIS BECAUSE OF THEIR STEEP SLOPE, ABOUT 20°.

COULEE CITY TO WATERVILLE TO WENATCHEE AUG 14 1923

PILOT ROCK OR HAYSTACK ROCK IS 40 FEET ABOVE THE MORAINE SURFACE ON THE WEST SIDE AND 70 FT ABOVE ON THE EAST. IT IS 600 FT IN PERIMETER ABOUT THE EDGE OF THE TALUS. IT STANDS 1000 FT ABOVE COULEE CITY.

OKANOGAN LOBE'S MORAINE ON THE PLATEAU NORTH OF WITHROW IS A MAGNIFICENT THING. IT RISES 150-200 FT ABOVE THE WHEAT LAND TO THE SOUTH WHERE THE RELIEF OF THE MATURE TOPOGRAPHY IS SMALL (50 FT FOR MAX). IT IS THE MOST IRREGULARLY AND TUMULTUOUSLY HEAPED PLEISTOCENE MORAINE I EVER SAW. IT IS MORE THAN A MILE WIDE AND BARREN OF VEGETATION, EXCEPT THE SAGE FLORA. AT A DISTANCE OF A MILE OR MORE, IT APPEARS BLUE-BLACK AND SET BACK OF YELLOW WHEAT LAND, IT IS MOST STRIKINGLY SET FORTH. IT IS MADE UP OF A NUMBER OF SHORT RIDGES, SOME OF WHICH LIE OUT ON THE PLAIN A THOUSAND FEET OR SO BEYOND THE MAIN MASS. THE EFFECT OF THE WHOLE IS THAT OF EXTREME RECENCY, FOR IT IS SHARP IN OUTLINE AND LOOKS AS THO VEGETATION HADNT YET GOTTEN A HOLD ON IT. IT IS VERY BOULDERY, HUGE BASALT BLOX (HAYSTACK ROX) BEING STREWN OVER IT. SOME OF THESE BLOX APPEAR TO HAVE ROLLED OFF THE FRONT OF THE ICE OUT ONTO THE PLAIN BEYOND THE LIMITS REACHED BY THE ICE ITSELF.

THE MATURE TOPOGRAPHY ABOUT WITHROW HAS BUT LITTLE RELIEF, DUE TO THE FLATNESS AND LEVELNESS OF THE BASALT SURFACE AND THE DISTANCE FROM MAIN DRAINAGE LINES NEARER WATERVILLE, THE RELIEF OF THIS TOPOGRAPHY IS MUCH GREATER AND THE BASALT IS CLOSE TO THE SURFACE.

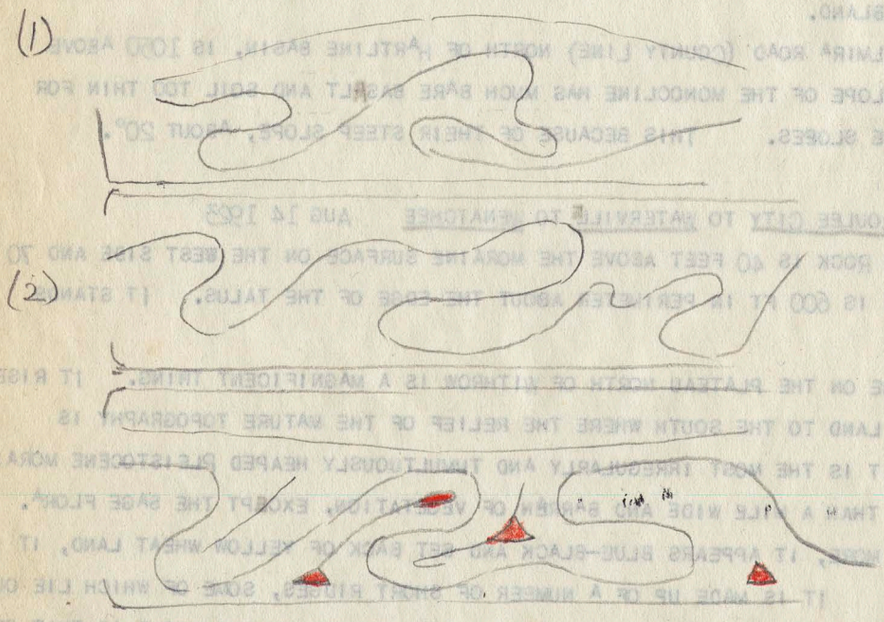
THE CREEK AT WATERVILLE IS IN A BROAD, FLAT-BOTTOMED LATE MATURE VALLEY TO THE BRINK OF THE VERY YOUNG, VERY STEEP-SIDED AND VERY DEEP CORBERLEY CANYON. THE ROLLING MATURE SLOPES, CONCAVE IN THEIR LOWER PORTIONS, COME RIGHT TO THE EDGE OF THE CANYON.

ALONG SUNSET HIWAY, 4-5 MILES NORTH OF WENATCHEE, IS A CUT SHOWING A SEASONALLY BANDED SILT ABOUT 200 FT ABOVE THE ALTITUDE OF WENATCHEE. 30-FOOT SECTION. SILT IS PALE BUFF IN COLOR. SOME PORTIONS A VERY FINE SAND, SOMEWHAT MORE GRAY OR BROWN COLORED. THE SEASONAL BANDING IS FAR FROM PERFECT THRUOUT. IN SOME PARTS OF THE SECTION, THE THIN WINTER CLAY AND THE THICK SUMMER SILT SHOW BEAUTIFULLY. IN SUCH SECTIONS, THE WINTER BANDS ARE MUCH THE SAME IN THICKNESS WHILE THE SUMMER BANDS VERY A GOOD DEAL. IN MOST SUMMER BANDS, IS A DELICATE FORESET OR CURENT BEDDING, SHOWING VERY GENTLE SOUTHWARD DRIFT OF THE MATERIAL ALONG THE BOTTOM. THIS DOESNT SEEM RIGHT FOR A WATER BODY WHICH RECORDED VARVE CLAYS. AND THERE ARE SEVERAL OTHER UNORTHODOX THINGS TOO.

PORTIONS OF THE DEPOSIT WHICH DO NOT SHOW VARVE CLAY STRATIFICATION ARE COMPOSED OF FINE SAND TO SILT, NOT OF CLAY. CURRENT BEDDING IS PROMINENT IN THIS, MUCH MORE SO THAN IN THE SUMMER VARVES.

HERE AND THERE IN THE SECTION ARE WORN PEBBLES AND COBBLES NOT OF BASALT OR THE LOCAL GRANITE. THESE UNDOUBTEDLY SHOW THE PRESENCE OF FLOATING ICE.

IN CERTAIN LAYERS OF THE FINER SILT ARE MOST PECULIAR CONTORTIONS OF THE LAMINAE, THO THE STRATA IMMEDIATELY ABOVE OR BELOW ARE NOT AFFECTED. SOME OF THESE CONTORTIONS WERE SKETCHED.



IN EACH SKETCH, ONE PROMINENT CONTINUOUS LAMINA HAS BEEN SHOWN. THE OTHERS ARE SQUEEZED OR THICKENED TO CONFORM. IN (3) THE LITTLE TRIANGULAR AREAS SHOW FRAGMENTATION AND POROSITY.

THESE PLICATIONS OR CONTORTIONS HAVE A STRIKE ! THEY ARE ROLLS ! AND THE STRIKE IS ESSENTIALLY PARALLEL TO THE WALL OF THE VALLEY HERE. OTHER EVIDENCE, IN THE EXISTENCE OF GENTLE FLEXURES IN THE STRATA THEMSELVES, SEEMS TO POINT TO SETTLING OF THE MATERIAL DOWN A SUBAQUEOUS SLOPE TOWARD THE DEEPER PARTS OF THE VALLEY AS THE CAUSE FOR THE DISTORTION. THE SECTIONS ABOVE ARE NOT AT RIGHT ANGLES TO THE STRIKE, PERHAPS ARE NEARER THE ANGLE OF THE STRIKE. HENCE THE AMOUNT OF PLICATION SEEMS GREATER THAN IT REALLY IS.

ANOTHER CURIOUS THING ABOUT CERTAIN STRATA IS THE CORRUGATED SURFACE OF A CLAY LAYER BENEATH A SAND LAYER. THE CORRUGATIONS LOOK SOMEWHAT LIKE RIPPLE MARKS BUT ARE SHAPED MORE LIKE A CURLING WAVE, AS COMMONLY DEPICTED JUST BEFORE BREAKING. SOME OF THE MUD CORRUGATIONS

ACTUALLY OVERHANG BY 90°. THE SAND HAS BEEN BLOWN OUT IN PLACES, LEAVING THESE MOST PECULIAR CORRUGATIONS BEAUTIFULLY EXPOSED. THE WHOLE SECTION DESERVES CAREFUL STUDY.

A BROAD GRAVEL TERRACE, NOT THE HIGHEST GRAVEL HOWEVER, BETWEEN ORONDO FERRY AND WENATCHEE, NORTH OF THE SILT SECTION, IS 100 FEET OR A LITTLE MORE ABOVE WENATCHEE

WENATCHEE TO PALISADES TO COULEE CITY AUG. 15 1923

ROCK ISLAND RAPIDS PHOTOGRAPHED FROM WEST SIDE RIVER, LOOKING UPSTREAM. OUGHT TO SHOW A SCABLAND CHANNEL IN THE MAKING.

TERRACE HERE IS STRIKINGLY MOUNDED, WITH MANY ENCLOSED BASINS. CLOSELY SPACED. RELIEF 10-20 FT. LOOKS SOMEWHAT LIKE MORAINIC TOPOGRAPHY BUT THE SLIGHT RANGE IN SIZE, THE LEVEL BASE ON WHICH THEY STAND AND THE SECTIONS WHICH SHOW RIVER GRAVEL IN AND BENEATH THEM DISPROVE THE MORAINE HYPOTHESIS.

THE SAME TERRACE ON EAST SIDE OF RIVER DOWN TO COLUMBIA RIVER STATION, AND AT SAME ALTITUDE. EXTENDS EASTWARD HERE OVER INTO MOSES COULEE AND A HIGHER ISOLATED TERRACE FRAGMENT LIES FARTHER SOUTH AT THE ANGLE OF CONFLUENCE OF COLUMBIA VALLEY AND MOSES COULEE. SHOWN ON MALAGA SHEET.

CLIFFS OF COLUMBIA VALLEY ON THE EAST, AT CONFLUENCE OF THE ROCK WALLS, HAVE SPOKANE TALUS. IT APPEARS TO REST ON THE TERRACE. IT MUST BE YOUNGER THAN THE TERRACE, ELSE THE TERRACE-FORMING WATERS WOULD HAVE REMOVED IT. THE MOUNDED TERRACE AT AN ALTITUDE OF 750 TO 800 AT ROCK ISLAND RAPIDS AND AN ALTITUDE OF 850 TO 875 AT COLUMBIA RIVER STATION IS A SPOKANE TERRACE.

IN THE LOWER MOSES COULEE, BELOW APPLEDALE AND ON THE MALAGA SHEET, THIS TERRACE IS PRESENT ALSO, THO LARGELY REMOVED IN THE DEVELOPMENT OF THE PRESENT FLOOR, 50-75 FT LOWER. WHERE PRESENT, THE TALUS ON THE WALLS BACK OF IT IS CLEARLY OF SPOKANE AGE. WHERE THE MAIN FLOOR ONLY IS PRESENT AT FOOT OF CLIFFS, THE TALUS AS CLEARLY IS WISCONSIN. ANOTHER STRIKING THING IS THE DEVELOPMENT OF ALLUVIAL FANS FROM THE TRIBUTARY VALLEYS OF THE COULEE ON THE TWO TERRACES AND IN ASSOCIATION WITH THE TWO AGES OF TALUS. ALLUVIAL FANS FROM TRIBUTARIES OF COMPARABLE SIZE ARE SEVERAL TIMES AS LARGE ON THE HIGHER TERRACE AND ASSOCIATED WITH THE SPOKANE TALUS, AS THOSE WHICH ARE ON THE MAIN FLOOR AND ASSOCIATED WITH WISCONSIN TALUS.

TWO WELLS AT APPLEDALE, BOTH DUG, ONE 260 FEET DEEP, ONE 300 FT DEEP, WITHOUT ENCOUNTERING BEDROCK. See Aug 23 '23 for well above Palisades.

THE THREE DEVILS ARE THREE EXCESSIVELY STEEP AND ROCKY GRADES IN THE ROAD EAST FROM PALISADES OUT OF MOSES COULEE. THESE GRADES ARE OLD CATARACTS IN SERIES, THE CANYONS LEFT BY THEIR RECESSION BEING AS STRIKING AS THE CATARACTS THEMSELVES. HAVING ATTAINED TO THE TOP OF THE UPPER ONE, THE VIEW EMBRACES THE SURFACE OF THE BASALT IN THE SYNCLINE NORTH OF BADGER HILLS. IT IS A SPOKANE SCABLAND, VERY DEEPLY TRENCHED BY SEVERAL GREAT CANYONS, THOSE OF THE THREE CATARACTS CONSTITUTING ONLY A PART OF THE GROUP. AND SPOKANE TALUS EVERYWHERE EXCEPT IN THE DEEPER CANYONS. THE CONCLUSION THAT WISCONSIN WATERS DID BUT LITTLE IN THE MOSES COULEE PLEXUS IS AMPLY SUSTAINED BY THIS YEAR'S RE-EXAMINATION.

EAST OF THE PLEXUS IS A BROAD FLAT, DETERMINED BY THE SAME SYNCLINE. LARGE GRAVEL BARS LIE IN ITS NORTHERN PART, WITH STEEP DELTA-LIKE FRONTS FACING SOUTHEASTWARD OUT OF THE PLEXUS. IT APPEARS THAT THE SPOKANE WATERS FOUND NO DRAINAGE LINE ACROSS THE SYNCLINE AND THAT THEY THEREFORE SPREAD OUT INTO A BROAD SHEET FOR A TIME UNTIL HEADWARD ~~EROSION~~ RECESSION OF A CATARACT

OR GROUP OF CATARACTS FROM PALISADES DRAINED THE STRUCTURAL VALLEY. DURING THIS FLOODED CONDITION, GRAVELS WERE DUMPED INTO THE SHALLOW LAKE—LIKE EXPANSION FROM THE NORTH, BUT FAILED TO AGGRADE A DELTA PLAIN ACROSS. THE SITUATION IS IDENTICAL WITH ROADSIDE DRAINAGE AFTER A HEAVY RAIN; A POOL OR PUDDLE BEING PARTIALLY FILLED BY A DELTA WHEN THE FAR SIDE BECOMES BREACHED AND THE WHOLE IS DRAINED.

PLATEAU BETWEEN MOSES AND GRAND COULEES AND SOUTH OF SUNSET HIWAY IS MUCH DIVERSIFIED BY STRUCTURAL RELIEF, THO NO SIMPLE SYSTEM IS APPARENT. THE BADGER HILLS ANTICLNE PERSISTS NORTHWARD ALONG LOWER GRAND COULEE NEARLY TO THE LATITUDE OF BLUE LAKE. FROM HERE NORTHWARD, THE FLOOR OF THE SYNCLINE northwest RISES AND THE ANTICLINE thus BECOMES A MONOCLINE.

THE SUNSET HIWAY (YELLOWSTONE TRAIL) BETWEEN SPENCER AND COULEE CITY CROSSES THE MORAINE FROM THE DRIFTLESS COUNTRY TO THE GROUND MORAINE AND BACK AGAIN. BUT THE MORAINE IS VERY POORLY DEVELOPED, COMPARED WITH ITS DEVELOPMENT NORTH OF WITHROW.

THE LOESS—OR—SILT—RESIDUAL EARTH—COVERED HILLS ARE MOSTLY BASALT NORTH OF THE SYNCLINE ABOVE DESCRIBED. ONLY A FEW FEET OF THE FINE SOIL. AND IN THE SLOPES FOR TWO OR THREE MILES NORTH OF THE AGGRADED FLAT IN THE SYNCLINE, THERE IS NONE OF THIS SOIL. SAND AND CRUMBLED BASALT CONSTITUTE THE ONLY SOIL. NO SUGGESTION HOWEVER HERE THAT THE SPOKANE OR WISCONSIN ICE EVER REACHED IT.

GRAND COULEE SCABLAND AUG 16 1923

NORTH OF BACON, SOUTH OF COULEE CITY.

THE FALLS WHICH LIE A MILE SOUTH OF CC HAVE TWO LAKES IN THE CANYON; CASTLE LAKE AT THE VERY FOOT, AND DEEP LAKE IN THE CANYON FARTHER DOWN. CASTLE LAKE IS SMALL AND LIES ON A ROCK LEDGE OR BENCH HIGHER THAN DEEP LAKE. DEEP LAKE IS ABOUT TWO MILES LONG AND SHEER CLIFFS COME DOWN TO THE WATER'S EDGE. DEPTH NOT KNOWN. FOR A QUARTER OF A MILE OR SO BELOW DEEP LAKE, THE FLOOR OF THE CANMON IS 50 FEET OR SO ABOVE THE LAKE SURFACE. IT HAS ROUNDED LOW PROTUBERANCES VERY MUCH LIKE THOSE PRODUCED IN RAPIDS OF THE COLUMBIA OVER THE BASALT. IT ALSO LAS A NUMBER OR REMARKABLE HOLES IN IT, 30 TO 40 FEET DEEP, 100 FT OR MORE ACROSS, SOME CIRCULAR, MORE OF THEM ELONGATED LIKE CHANNELS BUT CLOSED IN ON ALL SIDES. ALL OF THESE HOLES OR "WELLS" HAVE (OR HAVE HAD) VERTICAL SIDES. SOME ARE NOW INACCESSIBLE WITHOUT A ROPE OR LADDER. THEY VERY PROBABLY ARE POTHOLES DRILLED IN THIS PARTICULAR LEDGE BY THE CASTLE LAKE—DEEP LAKE CATARACT BEFORE ITS RETREAT HAD MADE THE DEEP LAKE CANYON.

NOT ALL THE TALUS OF THE CLIFFS IN THIS CANYON IS STRICTLY 1/2 OR LESS. BUT THE AVERAGE CERTAINLY DOES NOT EXCEED 1/2.

THE EASTERNMOST CANYON OF LOWER GRAND COULEE, HEADING BACK INTO THE COULEE CITY MID—CHANNEL SCABLAND, IS NOT THAT OF DEEP LAKE. IT TAKES ORIGIN ABOUT A MILE SOUTHEAST OF COULEE CITY. ITS HEAD IS CONSPICUOUSLY MARKED BY A GROUP OF LOMBARD POPLARS. ITS WALLS BEAR 3/4 OR HIGHER TALUS. APPARENTLY IT WAS NOT OCCUPIED BY WISCONSIN WATERS. ITS HEAD IS 50 FT ABOVE COULEE CITY STATION WHILE THE LOWEST PLACE IN THE CHANNEL TO DRY FALLS CROSSED BY SUNSET HIWAY IS 75 FT BELOW THIS DATUM. THE WISCONSIN FLOOD OVER DRY FALLS AND DEEP—CASTLE FALLS THEREFORE WAS NOT DEEP ENOUGH TO REACH THIS SPILL OVER THE GREAT LEDGE. ASSUMING THAT THE WISCONSIN WATERS DID NOT LOWER THE MAIN CHANNEL TO DRY FALLS, THAT RIVER WAS NOT QUITE 125 FEET DEEP. WHATEVER LOWERING IN THE CHANNEL DID OCCUR WOULD CORRESPONDINGLY DECREASE THIS FIGURE. THIS IS FURTHER EVIDENCE THAT THE SPOKANE FLOOD WAS FAR GREATER THRU GRAND COULEE THAN THE WISCONSIN

AND THAT THE FALLS HAD DEVELOPT AND RETREATED TO WITHIN A MILE OF THE LATITUDE OF COULEE CITY DURING THE SPOKANE FLOOD.

THE SCABLAND BETWEEN COULEE CITY AND BACON AND EAST OF GRAND COULEE IS ALL OF SPOKANE AGE. ONLY ONE CANYON, PROBABLY THE LOWEST OF THEM ALL, SHOWS ANY SUGGESTION OF TALUS YOUNGER THAN SPOKANE.

OF THE THREE CANYONS WHICH OPEN INTO THE BACON SYNCLINE FROM THIS SCABLAND, ONE DOES NOT LEAD THRU FROM GRAND COULEE. THIS IS THE WESTERNMOST. IT HEADS IN THE SCABLAND. AND THE ONE USED BY THE RAILROAD NORTH OF BACON IS BUT A DISTRIBUTARY CANYON OF THE MIDDLE ONE OF THE THREE. FARTHER NORTH, THE RR IS IN ANOTHER CANYON, A TRIBUTARY OF THE MIDDLE ONE. THUS OF THE THREE, ONLY ONE REALLY CROSSES THE SCABLAND FROM GRAND COULEE TO DRY COULEE. BUT ANOTHER ONE WAS FOUND, A RELATIVELY SHORT ONE, WHICH LEADS OUT OF GRAND COULEE NEAR THE FOOT OF DEEP LAKE AND BACK INTO IT SOMEWHERE NEAR THE HEAD OF BLUE LAKE.

COULEE CITY TO ADRIAN TO GLOYD TO WHEELER TO NEPPEL AUG 17 1923

WISCINSIN WATERS IN SMALL QUANTITY APPEAR TO HAVE SPILLED OVER INTO DRY COULEE AT BACON AND THENCE TO ADRIAN. THE BIG GRAVEL FILL IN THE LOWER PART OF DRY COULEE AND OUT INTO CRAB CREEK VALLEY AT ADRIAN IS UNDOUBTEDLY OF SPOKANE AGE. THE ONLY WISCONSIN MODIFICATION IS THE EXCAVATION OF A TRENCH IN IT ABOUT 100 FT DEEP, JOINING THE CRAB CREEK VALLEY AT GRADE NEAR ADRIAN.

TO MAKE THE ADRIAN GRAVEL SPOKANE IN AGE IS TO SIMPLIFY AND MAKE MORE HARMONIOUS THE INTERPRETATION OF THE RELATION OF COULEES AND THE QUINCY VALLEY FILL. ALL THE GREAT GRAVEL DEPOSITS ARE SPOKANE, NEAR ADRIAN, THEY ALL HAVE ABOUT THE SAME LEVEL, INCLUDING THE STRATFORD TERRACE (BIG 4 ORCHARDS), THE ADRIAN TERRACE AND THE BIG ISOLATED GRAVEL MESA SOUTH OF SOAP LAKE AND NORTH OF MOSES LAKE. GREAT GRAVEL COVERED AREAS ABOUT GLOYD ALSO FALL INTO THIS CATEGORY. THE ONLY CHANGES WROUGHT BY WISCONSIN DRAINAGE ARE THE THREE BIG VALLEYS SHOWN ON THE WINCHESTER AND MOSES LAKE SHEETS.

BUT WHAT CONDITIONS SHOULD CAUSE THESE GRAVELS TO BE DEPOSITED BY THE SAME GLACIAL FLOOD WHICH ERODED THE CANYONS OF CRAB, CON-NA-WAI, WILSON, LAKE AND DUCK CREEKS AND SPRING, DRY AND GRAND COULEES? TWO HYPOTHESES MAY BE ENTERTAINED. ONE——— THAT UPLIFT OF THE DRUMHELLER PALISADES AND BRENCHMAN SPRINGS DISCHARGEWAYS. THIS HAS NOTHING TO RECOMMEND IT AND CANNOT BE ENTERTAINED WITHOUT GOOD CONFIRMATORY EVIDENCE. THE OTHER——— THAT THE CANYONS WERE ERODED BEFORE THE GRAVELS HAD ACCUMULATED IN QUANTITY IN THE MOSES LAKE-QUINCY BASIN, AND THAT THEIR ACCUMULATION DEMANDED A HIGHER GRADIENT ACROSS THE DEPRESSED TRACT. THIS EVENTUALLY BACKED UP THE GRAVELS IN THE COULEES, WHICH AT THAT TIME WERE CONTRIBUTING WATER. GRAND COULEE HAD CUT DOWN TO SUCH AN EXTENT BY THIS TIME THAT SPRING COULEE RECEIVED NO OVERFLOW FROM HARTLINE BASIN, OR AT THE BACON COL. HENCE, NO GRAVEL DEPOSIT THERE. AND GRAND COULEE, IF FILLED IN PART WAS WAS DRY COULEE, WAS LATER CLEANED OUT BY WISCONSIN WATERS, AS DRY COULEE WAS IN PART.

A GREAT GRAVEL PLAIN BETWEEN ADRIAN AND GLOYD. SOME SCABLAND BASALT PROJECTING ABOVE THE GRAVEL NEAR ADRIAN, AND SOME CHANNELWAYS, IN PLACES CUT TO BASALT, AND WITH SCABLAND FLOORS, NORTHEAST OF GLOYD. THEY LEAD FROM CRAB CREEK CANYON, NEAR THE TOWN OF WILSON CREEK, OVER TO THE MOSES LAKE DEPRESSION. ANOTHER SPILLWAY OUT OF CRAB CREEK SOUTHWARD NEAR KRUPP (MARLIN). EXACT PLACE NOT SEEN. PROBABLY THE GRAVEL DEPOSIT ALONG AND EAST OF THE CONNELL NORTHERN IS THIN. AND PROBABLY IT RESTS ON A SCABLAND BASALT FLOOR.

Err. AN ISOLATED PALOUSE HILL WITH A FARM BLDG GROUP, VISIBLE FOR MILES, STANDS 2 1/2 MILES EAST OF GLOYD. GRANITE BOULDERS ABOUT ITS BASE TELL OF GLACIAL WATERS WHICH ISOLATED IT.

ROCKY COULEE NORTH OF WHEELER JUST EAST OF THE GRAVEL PLAIN, JUST WITHIN THE PALOUSE HILL TOPOGRAPHY, IS 150 FEET DEEP. IT HAS GENTLY SLOPING SIDES WHICH ARE CONCAVE IN THEIR LOWER PORTIONS, AND A FLOODPLAIN NEARLY HALF A MILE WIDE. NO SIGN OF OCCUPATION BY GLACIAL WATERS. PROBABLE THAT AGGRADATION BY GRAVEL HERE HAS COVERED ANY RAVAGES THE GLACIAL STREAM EVER MADE. NOT MUCH MODIFICATION WAS PRODUCED ANYWAY, JUDGING FROM WHAT WAS SEEN NORTHWEST OF RITZVILLE AND AT MARCELLUS. (AUG 8 NOTES)

IF CRAB CREEK CANYON WAS MADE BY DEEPENING AND WIDENING THE PRE-SPOKANE VALLEY, AND
IF ITS DEEPENING AND WIDENING DREW THE WIDESPREAD GLACIAL WATERS OFF THE MARGINING SCABLAND, and
IF NO DEEP-CUT DRAINAGE LINE EXISTS SOUTH OF KRUPP (MARLIN) AND WILSON CREEK (TOWN) TO THE GRAVEL PLAIN ABOUT GLOYD AND BLACK ROCK SPRINGS,
THEN THIS GRAVEL PLAIN WAS DEPOSITED BEFORE THE CANYONS WERE COMPLETED.
THIS IS AN INCONGRUITY WHICH MUST BE GOTTEN RID OF.

LATER— NOT AN INCONGRUITY IF ALL GRAVELS ARE CONSIDERED AS BARS, DEPOSITED ONLY WHEN AND WHERE LOCAL CONDITIONS FAVORED, AND NOT A RECORD OF A TIME WHEN SCABLANDS WERE FILLED WITH GRAVEL, LATER TO BE ERODED.

NEPPELL TO OTHELLO AUG 18 1923

RELIEF OF PLATEAU ABOUT WHEELER IS SLIGHT. ALTITUDE ALSO IS BUT LITTLE ABOVE MOSES LAKE GRAVEL FILL; SO LITTLE THAT THE TRANSITION FROM PRE-SPOKANE PLATEAU SURFACE TO THE SPOKANE GRAVEL PLAIN IS HARDLY NOTICED EXCEPT FOR THE APPEARANCE OF GRAVEL IN POST HOLES AND OTHER EXCAVATIONS. HOWEVER, WHEN THE PLATEAU IS APPROACHED FROM THE GRAVEL PLAIN, THE CHANGE IS NOTICEABLE.

PLATEAU CONSIDERABLY WARPED NORTH OF WARDEN. COURSE OF LIND COULEE IS HERE CONTROLLED BY A BROAD, SHALLOW DOWNWARP, WITH HIGHER TRACTS (ANTICLINAL UPWARPS) ON THE NORTH AND SOUTH. THESE HIGHER AREAS HAVE THE MATURE DRAINAGE PATTERN WELL DEVELOPED, BUT THE FLAT-FLOORED DOWNWARP IS ALMOST PERFECTLY PLANE.

GRANITE, ETC., IN GRAVEL OF STREAM COURSE PAST TIFLIS. A DEEP ALLUVIUM HERE, 30-40 FEET THICK. STREAM IS NOW TRENCHING IT. NO EVIDENCES IN VALLEY FORM THAT GLACIAL WATERS EVER OCCUPIED IT. NOR DOES LIND COULEE NORTH OF WARDEN SHOW ANY SIGNS OF GLACIAL WATERS THO IT CERTAINLY RECEIVED THEM.

DRUMHELLER CHANNELS RE-EXAMINED. THE EASTERNMOST OF THE CHANNELS AT THE HEAD, THE ONE WHICH HAS A NORTHERN GRAVEL WALL AND A BASALT WALL ON THE SOUTH, FLOWS TO LIND COULEE WHICH, FROM THIS JUNCTION TO ITS ENTRANCE TO CRAB CREEK, BECOMES A PART OF THE GREAT ERODED AREA CALLED THE DRUMHELLER PLEXUS.

WEST OF WARDEN AND A LITTLE UPSTREAM FROM THE ERODED BASALT AREA, ARE SECTIONS OF A SUPER- BASALT SEDIMENTARY IN LIND COULEE. THE BASALT BENEATH IS WEATHERED. THE LOWER FOOT OR SO OF THE DEPOSIT IS OF POORLY SORTED, LITTLE WORN BASALTIC GRAVEL. ABOVE THAT IS 6-10 FEET OF A CHOCOLATE-BROWN, FORESET-BEDDED, EARTHY SEDIMENT, PROBABLY COARSE RESIDUAL EARTH FROM BASALT. ABOVE THAT IS 20 FEET OR SO OF A THIN-BEDDED, JOINTED, BLOCKY, BUFF-COLORED CLAY. A FEW FEET

OF CALICHE LIMESTONE CAPS THE SECTION. NO TRACE OF ORGANISMS FOUND. NO PEBBLES NOT DERIVABLE FROM THE BASALT. NO DEFORMATION SEEN. MORE SECTIONS OF THE SAME SEDIMENT, WITH ABOUT THE SAME MEMBERS IN THE SAME SEQUENCE, A MILE AND A HALF NORTH OF OTHELLO. PROBABLY ELLENSBURG OR EQUIVALENT. IMPROBABLE THAT IT IS PLEISTOCENE. HOW MUCH OF THE SILT BENEATH THE GRAVEL IN MOSES LAKE BASIN IS THE SAME??

A RE-STUDY OF THE DRUMHELLER CHANNELS AFTER THE ELABORATION OF THE TALUS CRITERION OF AGE IS A LITTLE DISCONCERTING. MOST OF THE TALUS IS AS HIGH AS IN THE SPOKANE CHANNELS ON THE PLATEAU. AND ALMOST ALL OF IT IS SOIL-COVERED AND GRASSED. THERE IS VERY LITTLE BARE ROCK TALUS. BUT SOME ISOLATED MESAS, NOTABLY THAT AT THE DOWNSTREAM JUNCTION OF CRAB CREEK AND GOOSE LAKE CHANNELS, HAVE GOOD ROCKY WISCONSIN TALUS.

THIS RANGE IN HEIGHT AND THIS SOIL-COVERED CONDITION WITH PAUCITY OF ROCK TALUS, IS EXPLICABLE HOWEVER WHEN THE AMOUNT OF EOLIAN SAND IN THE CHANNELS IS CONSIDERED. THERE IS A GREAT DEAL OF IT. BELOW JUNCTION OF CRAB AND GOOSE LAKE CHANNELS, THE BIG WEST WALL IS ALMOST ALL SAND, COVERING THE ROCK CLIFF ALMOST COMPLETELY. THERE ARE MANY SAND HILLS AND RIDGES IN THE PLEXUS AND IN MANY PLACES THE SAND HAS LODGED SO THAT IT CLIMBS FROM CHANNEL FLOOR TO CLIFF SUMMIT AND IS MOUNDED UP ON THE SUMMIT AREAS. IT SEEMS CLEAR ENOUGH, AFTER CAREFUL EXAMINATION THAT SAND HAS BEEN BLOWN IN HERE DURING ALL POST-WISCONSIN TIME AND CONSTITUTES A LARGE PART OF THE TALUS FILL. A ROAD SECTION IN ONE PLACE IN A TALUS SLOPE SHOWS MORE SAND THAN ROCK FRAGMNTS.

BECAUSE OF THIS ABUNDANCE OF WIND-BLOWN SAND, ALL OVER THE PLEXUS, THE CHANNELS CANNT BE USED AS AN EXAMPLE OF WISCONSIN TALUS. THO WHERE THERE ARE LOCALLY FAVORING CONDITIONS, THE ACCUMULATION OF SAND HAS NOT BEEN SUFFICIENT TO MODIFY THE WISCONSIN CHARACTER.

SPOKANE GLACIAL DRAINAGE SOUTH OF OTHELLO AUG. 19

THE GLACIAL RIVER WHICH FLOWED SOUTHWARD PAST THE EAST END OF SADDLE MTS. LEFT A CHANNEL WHICH IS 150 FEET DEEP AND A MILE WIDE AT THE ADAMS-FRANKLIN CO. LINE. COARSE, BASALTIC GRAVEL IS EXPOSED AT THE UPPER LIMIT ON THE EAST. POSSIBLY IN EARLIEST STAGES THE WATERS SPREAD EVEN FARTHER EAST OVER ON THE FLATTISH REGION SOUTH OF OTHELLO. OTHELLO IS ON A BENCH WHICH PERHAPS WAS CUT BY GLACIAL WATERS.

THE GLACIAL STREAM IN CROSSING THE ANTICLINE LITERALLY DISEMBOWELLED THE TRACT IT SWEPT OVER. FOR A WIDTH OF ABOUT TWO MILES, THE BASALT IS GREATLY GASHED AND CANYONED, CLIFFS 200 FEET OR MORE IN HEIGHT OVERLOOKING CANYONS AND ROCK BASINS. THE DISEMBOWELLING WAS DONE IN THE AXIAL AND SOUTHERN FLANK OF THE ANTICLINE. THE NORTHERN (AND STEEPER) LIMB IS ERODED INTO PROMINENT SHORT HOGBAX IN LINE (STR. N80E, DIP 19° N), THEN NOTCHES BETWEEN THEM LEADING TO THE CANYONS. THE WHOLE AFFAIR IS A DRUMHELLER CHANNELS ON A SMALLER SCALE. PART OF THE ANTICLINAL NOSE LIES EAST OF THIS ERODED TRACT. SPOKANE TALUS WELL DEVELOPT ON THE CLIFFS. NO NOTEWORTHY QUANTITY OF DRIFTING SAND IN THE CHANNELS AREA.

SOUTH OF THE ANTICLINE, THE GLACIAL STREAM SPREAD WIDELY, SWEEPING OFF THE SEDIMENTARY FORMATION WHICH HERE OVERLAY THE BASALT AND ERODING CANYONS IN THE BASALT. THE SEDIMENTARY MAY BE RINGOLD BUT PROBABLY IS ELLENSBURG OR EQUIVALENT.

THE AREA OVER WHICH THE GLACIAL FLOOD SPREAD WAS 9 MILES WIDE AT THE CAMPBELL SCHOOL LATITUDE. ALL THE WATER ON THIS AREA CAME THRU THE SADDLE MTS CHANNELS, WHERE THE CHANNEL IS BUT A MILE WIDE, THO 150 FEET DEEP (?? SOMETHING WRONG) (SEE AUG. 21 NOTES) AS ABOVE INDICATED IT MAY HAVE BEEN SOMEWHAT WIDER AT THE INCEPTION OF THE FLOOD BUT THIS CONDITION DID NOT LAST

LONG AND THE SIZE OF THE STREAM NECESSARY TO DENUDE THE BASALT OVER A NINE-MILE WIDTH IS EXPRESSED BY THE CROSS-SECTION 1 MILE X 150 FT. (SEE AUG. 21 NOTES ON THIS)

NO!! THIS CANNOT BE RIGHT! ON THE FRANKLIN CO SOIL MAP THE AREA SWEPT BY THE WATERS AT THE NORTHERN EDGE OF THE COUNTY IS 6 MILES WIDE. TWO MILES MAY MEASURE THE WIDTH OF THE PROMINENT CANYONING BUT THE EARLY STREAM MUST HAVE BEEN CONSIDERABLY WIDER THAN THIS/ 1 MI.X 150 FT. CHANNEL.

A PROMINENT GRAVEL TERRACE, PERHAPS A FLAT-TOPT BAR, LIES 4 MILES WEST OF CAMPBELL SCHOOL. THE GRAVEL IS 65-75 FEET THICK. ITS LOCATION DOWNSTREAM FROM AN ISOLATED HILL OF THE PRE-SPOKANE TOPOGRAPHY SUGGESTS THAT IT IS A BAR.

KOONTZ COULEE AFFORDS SOME INTERESTING INFORMATION RELATIVE TO THE DEPTH OF COLUMBIA RIVER VALLEY DURING THE SPOKANE EPOCH. THE COULEE IS CUT IN THE RINGOLD FORMATION. AT ITS JCT. WITH THE COLUMBIA, THE RINGOLD SILTS AND CLAYS ARE EXPOSED TO THE COLUMBIA FLOODPLAIN. ABOUT 200 FEET DIFFERENCE IN ALTITUDE BETWEEN THE FLOOR OF THE COULEE AND THE SURFACE OF THE COLUMBIA. FLOOR OF COULEE BEARS A BASALTIC GRAVEL WHICH IS A DEPOSIT OF THE GLACIAL STREAM, NOT A HORIZON IN THE RINGOLD. THIS STREAM EASILY CUT DOWN TO THE LEVEL OF THE SPOKANE COLUMBIA. THERE COULD HAVE BEEN NO HOLDING UP OF A WATERFALL OR CASCADES AT THE JCT. THEREFORE, THE COLUMBIA AT THIS TIME WAS FLOWING 200 FEET ABOVE ITS PRESENT LEVEL.

KOONTZ COULEE HAS THE STEEPENED SIDES AND THE SMALL HANGING OR SHORT REJUVENATED TRIBUTARY VALLEYS WHICH CHARACTERIZE THE WALLS OF GLACIAL DRAINAGE CHANNELS IN THE SPOKANE-PALOUSE AREA. IT IS 250 FEET DEEP.

WEST OF MESA 8 MILES, THE BLUFF OF RINGOLD MATERIAL ALONG THE WESTERN MARGIN OF THE DENUDED AREA IS 325 FEET HIGH.

THE RINGOLD FORMATION OBVIOUSLY IS OLDER THAN SPOKANE. ITS SURFACE IS A GREAT FLAT; LARGELY UNTOUCHED BY STREAM EROSION. YET IT LIES HIGHER, APPARENTLY, THAN THE MATURELY ERODED VALLEYS OF RYE GRASS AND OLD MAID COULEES EAST OF ESQUATZEL COULEE. IT IS YOUNGER THAN THE MATURE TOPOGRAPHY.

BUT IF THE RINGOLD WAS DEPOSITED AFTER THE MATURE TOPOGRAPHY WAS DEVELOPED AND ITS SURFACE IS HIGHER THAN THE VALLEYS OF THIS TOPOGRAPHY, WHY WERE THEY NOT SILTED UP TO THAT LEVEL ??

FROM ELTOPIA TO CONNELL, THE HIGHWAY IS LOCATED ON THE DIVIDES IN THE PALOUSE TOPOGRAPHY. SEVERAL STRIKING CASES OF STEEPER NORTHERN SLOPES AND GENTLER SOUTHERN SLOPES IMMEDIATELY ABOVE THE VALLEY BOTTOMS WERE SEEN. BUT THE RELATIONSHIP ISNT INVARIABLE. IT ISNT RECOGNIZABLE AT ALL IN THE DEEPER, MAJOR VALLEYS.

A GRAVEL DEPOSIT IN OLD MAID COULEE, 4 1/2 MILES SOUTH OF CONNELL ON THE HIGHWAY, HAS BEEN OPENED FOR ROAD MATERIAL. 15 FEET OF GRAVEL, WITH SOME SAND, UNDERLIE 3 FEET OF HIGHLY CALCAREOUS SILT, SOME OF IT A PURE WHITE CHALKY LIME. THIS IS OVERLAIN BY 10 FT OF LOESS. AND THIS LOESS IS LOESS, NOT A RESIDUAL SOIL FROM BASALT. THE GRAVEL IS ONLY SLIGHTLY INDURATED OR STAINED BUT THE BASALT PEBBLES AND COBBLES ARE EASILY FRACTURED FROM WEAKENING BY DECAY. THO LITTLE IRON STAIN OR EXFOLIATION OF COBBLES IS APPARENT, YET THE DEPOSIT SHOWS EVIDENCE OF AGE.

THE GRAVEL IS FORESET, WITH DIP DOWN THE PRESENT COULEE. COMMON IN THE BASALTIC MATERIAL ARE PEBBLES AND SOME COBBLES OF A YELLOW GRANULAR QUARTZITE. NOTHING BUT BASALT AND QTZITE FOUND, SAVE ONE PEBBLE OF DENSE GREY LIMESTONE, UNLIKE THE WHITE, CHALKY LIMESTONE FOUND IN THE

LOESS OF THE PLATEAU. THERE IS NO EVIDENCE IN THE TOPOGRAPHY THAT SPOKANE WATERS EVER FLOWED DOWN OLD MAID COULEE. AND THO GRANITE IS BY FAR THE MOST COMMON ERRATIC MATERIAL OF THE SPOKANE GRAVEL DEPOSITS, NO GRANITE WAS FOUND IN THIS PIT.

IT SEEMS PROBABLE THAT THIS DEPOSIT WAS MADE ON THE BASALT PLATEAU BY STREAMS WHICH FLOWED ACROSS IT BEFORE THE LOESS WAS DEPOSITED. THIS INTERPRETATION DEMANDS THE ASSUMPTION THAT THE PRESENT POSITION IN, AND DIP OF FORESET BEDDING WITH, OLD MAID COULEE IS A COINCIDENCE. YET HOW CAN IT BE OTHERWISE FOR THE PRESENT DRAINAGE LINE ENCOUNTERS NO QUARTZITE.

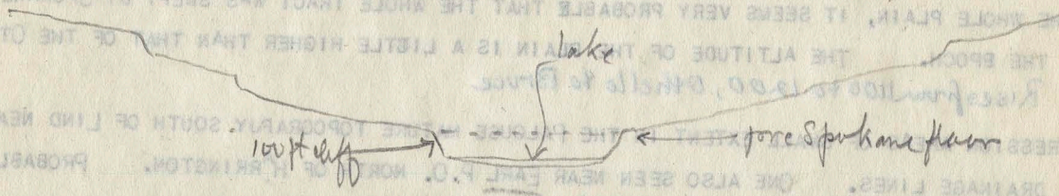
THERE ARE TERRACES IN OLD MAID COULEE, ABOUT AS HIGH ON THE VALLEY SLOPES AS THE DEPOSIT IN QUESTION. IF THEY ARE COMPOSED OF GRAVEL OF THE CHARACTER OF THAT IN THE DEPOSIT, THEN THIS GRAVEL WOULD LOGICALLY BE A DEPOSIT IN AND BY THE PRESENT DRAINAGE. AND SOME SOURCE FOR THE QTZITE WOULD HAVE TO BE FOUND WITHIN A FEW MILES TO THE NORTHEAST. THIS SEEMS VERY IMPROBABLE.

WASHTUCNA COULEE AUG. 19 1923

HIGHEST GRAVEL TERRACE AT ESTES ON SOUTH SIDE OF COULEE IS 250 FEET ABOVE COULEE FLOOR.

TOP OF BASALT, BASE OF PALOUSE LOESSIAL FORMATION, ON WEST SIDE OF DEVILS CANYON A MILE AND A HALF SOUTH OF KAHLOTUS, IS 550 FT ABOVE KAHLOTUS, 1350 AT.T THIS IS ABOUT THE ORIGINAL LEVEL AT WHICH THE GLACIAL WATERS SPILLED OVER TO THE SNAKE. ORIGINAL SPILLWAY MAY HAVE BEEN A LITTLE HIGHER BECAUSE OF THE PALOUSE FORMATION. THE BASALT WAS ERODED 450 FEET AT THIS PLACE.

WASHTUCNA COULEE PROFILES ARE VERY DIFFERENT FROM DEVILS CANYON PROFILES. THE FORMER IS MUCH BROADER AT TOP AND BOTTOM // BOTH, IN PROPORTION TO DEPTH AND ITS SLOPES ARE FAR LESS PRECIPITOUS. IT HAS SCABBY SLOPES BUT NOTHING VERY STRIKING IN THE WAY OF CLIFFS. THE GLACIAL WATERS SIMPLY ROUGHENED THE EDGES OF BASALT FLOWS IN THE PRE-SPOKANE VALLEY, THE OLD PALOUSE ~~PALOUSE~~ VALLEY OF THE MATURE TOPOGRAPHY. THE DEEPENING PROBABLY DID NOT MUCH EXCEED 100 FT. AT KAHLOTUS, AS INDICATED BY THE CANYON IN WHICH THE LAKE LIES AND BY THE ROCK ISLAND IN THE LAKE AND ANOTHER ROCK KNOB AT ESTES.



IF WASHTUCNA COULEE HAS BEEN DEEPENED NO MORE THAN 100 FT OR SO, THEN THE SPOKANE FLOOD IN IT MUST HAVE BEEN 450 FEET IN DEPTH TO GIVE ORIGIN TO DEVILS CANYON SPILL. THIS, DESPITE THE FACT THAT WASHTUCNA COULEE WAS OPEN TO ESQUATZEL COULEE AND THIS TO THE SNAKE-COLUMBIA VALLEY AT THE TIME.

THE BIG GRAVEL DEPOSIT ON THE SOUTH SIDE OF THE COULEE AT WASHTUCNA IS BUT A BAR, AS ITS OUTLINE, ITS ROUNDED SURFACE AND ITS POSITION WITH REFERENCE TO THE ROCK-BOUND CHANNELS PROVES. THIS DEPOSIT WAS THE NEAREST APPROACH TO EVIDENCE FOR THE RIVAL INTERPRETATION THAT THE SPOKANE CHANNELS WERE EVER COMPLETELY FILLED WITH GRAVEL, AND THEN RE-EXCAVATED. AND NOW THIS IS DESTROYED AS EVIDENCE.

GRAVEL DEPOSITS NORTH OF WASHTUCNA, HIGH UP ON THE COULEE WALLS AND WITH FLATTISH TOPS, INDICATE THAT THE MAIN COULEE CONTAINED WATER TO THAT LEVEL, 350 FEET ABOVE WASHTUCNA STA.

WASHTUCNA TO LIND; MICHIGAN PRAIRIE AUG 21

ON HIWAY UP FROM WASHTUCNA, BASALT IS EXPOSED 525 FEET ABOVE WASHTUCNA STATION. THE SUMMIT OF THE PALOUSE HILLS NEARLY IS 650 PALOUSE SOIL HERE IS THEREFORE ABOUT 100 FT DEEP.

A WELL ON THE HILLY COUNTRY BETWEEN MICHIGAN PRAIRIE AND LIND PENETRATES 99 FEET OF PAL. SOIL. AND IT IS LOCATED 30 FT OR SO BELOW THE HILLTOPS.

MICHIGAN PRAIRIE IS A GREAT FLATTISH TRACT OF THE BASALT PLATEAU, UNAFFECTED BY WARPING OR BY EROSION. THO THERE ARE DRAINAGE LINES OF MATURE ASPECT ON IT, THEY ARE SHALLOW.

THE HIGHER AREA BETWEEN MICHIGAN PRAIRIE AND LIND IS ABOUT 300 FT ON THE AVERAGE ABOVE THE PRAIRIE. THE PRESENCE OF BASALT IN WELLS 100 FT OR SO BELOW THE TOP OF THESE HILLS SHOWS THE ALTITUDE OF THE TRACT TO BE DETERMINED BY ANY UPWARP.

THE SOUTHERN MARGIN OF THE PRAIRIE IS MARKED BY A SERIES OF LINEAR HILLS, ARRANGED EN ECHELON, THE AXES TRENDING NEARLY NE–SW AND THE RANGE NEARLY E–W SEEN IN THE FIELD, AFTER THE COLUMBIA PLATEAU'S PHYSIOGRAPHIC CONTROL BY STRUCTURE HAS BEEN WELL COMPREHENDED, THESE HILLS ARE CLEARLY FOLDS IN THE BASALT. THEIR CLOSE RESEMBLANCE TO FEATURES OF THE PLATEAU BETWEEN SNAKE RIVER AND WASHTUCNA COULEE, ESPECIALLY ABOUT DUNNIGAN COULEE AND RYE GRASS FLAT, MAKE A GOOD WORKING HYPOTHESIS THAT STRUCTURE OF THIS SORT DETERMINES THE DRAINAGE PATTERN. THE WALLULA SHEET SHOWS THE SAME PATTERN. THE MAIN DRAINAGE LINES LIE IN THE SYNCLINES AND THE MINOR ONES LIE BETWEEN THE EN ECHELON WRINKLES OF THE COMPOUND ANTICLINES.

THE FOLDING ALSO SHOWN, THO POORLY, IN SECTION IN EAST WALL OF DEVILS CANYON.

OTHELLO CHANNELS AUG 21 1923

A LARGE PLANE AREA EXTENDS FIVE MILES EAST OF OTHELLO TO THE FOOT OF THE TRUE PALOUSE TOPOGRAPHY HERE, AND SOUTHWARD TO THE WIDE GAP CUT BY GLACIAL WATERS ACROSS THE EAST END OF THE SADDLE MTS. ANTICLINE. THO NO SECTIONS OR WELL LOGS WERE SECURED, AND A SANDY SOIL COVERS THE WHOLE PLAIN, IT SEEMS VERY PROBABLE THAT THE WHOLE TRACT WAS SWEPT BY SPOKANE WATERS EARLY IN THE EPOCH. THE ALTITUDE OF THE PLAIN IS A LITTLE HIGHER THAN THAT OF THE OTHELLO STATION. Rises from 1100 to 1200, Othello to Bruce

DEPRESSION AREAS OF SMALL EXTENT IN THE PALOUSE MATURE TOPOGRAPJY SOUTH OF LIND NEAR THE HEADS OF DRAINAGE LINES. ONE ALSO SEEN NEAR EARL P.O. NORTH OF HARRINGTON. PROBABLY DUE TO DRIFTING OF LOESS AND SAND SINCE THE MATURE TOPOGRAPHY WAS FORMED.

A CURIOUS REVERSAL IN DIRECTION IN A SMALL STREAM IN THE HILL AREA SOUTH OF LIND. EXPLICABLE ONLY IN TERMS OF AN ORIGINAL WARPED SURFACE OF THE BASALT WHOSE UPLIFT DETERMINES THE HILL GROUP. SHOWN ON CONNELL SHEET.

WASHTUCNA COULEE

BOTTOM OF A PROMINENT PALOUSE TOPOGRAPHY VALLEY, ON NORTH SIDE OF THE COULEE AND ABOUT A MILE WEST OF KAHLOTUS, INDICATES THE PROBABLE ALTITUDE OF THE FLOOR OF THE PRE–SPOKANE VALLEY WHICH IS NOW WASHTUCNA COULEE. THE BOTTOM OF THE TRIBUTARY IS 250 FEET+ ABOVE THE PRESENT COULEE FLOOR.

WASHTUCNA, RATTLESNAKE FLAT, COW CREEK TO HOOPER AUG. 22 1923

GLACIAL DRAINAGE CHANNELS PERFECTLY DEFINITE NORTH OF WASHTUCNA TO LATITUDE OF OLD FLETCHER P.O. BUT ABOUT BEMIS, THE PALOUSE FORMATION SEEMS THIN AND THE COUNTRY IS RATHER FEATURELESS, AS THO GLACIAL WATERS MIGHT HAVE SWEPT OVER IT. FURTHER, A GLACIAL DRAINAGE CHANNEL WAS MAPT EAST OF LEON, HEADING TOWARD BEMIS, AND TO AVOID IT, THE WATER MUST HAVE SWUNG RATHER ABRUPTLY 3 MILES TO THE EAST WHERE THE BOUNDARY BETWEEN SCABLAND AND LOESSIAL SOIL IS DRAWN. LINE MUST BE LEFT INDEFINITE, IT SEEMS.

COW CREEK CANYON LOOKS SUSPICIOUSLY AS THO WHOLLY THE PRODUCT OF GLACIAL SPILL. NONE OF THE SLOPING SCABBY VALLEY WALLS WHICH CHARACTERIZE WASHTUCNA COULEE. AND KNOBS AND MESAS FAIRLY COMMON WITHIN THE WALLS OF THE CANYON.

HOOPER TO WINONA TO EWAN AUG. 22 1923

SCABLAND TRACT SOUTH OF HOOPER ABOUT 2 MILES WIDE BETWEEN PALOUSE RIVER AND THE MATURE TOPOGRAPHY TO THE SOUTH. SEVERAL STRIKING ISOLATED HILLS OF PALOUSE LOESS NEAR THE SOUTHERN MARGIN. ONE WAS PHOTOGRAPHED FROM SEVERAL ANGLES. MUCH ELONGATED, VERY NARROW CREST, EXCEPT NEAR HIGHEST PART, MORE THAN HALF A MILE LONG, SIDE SLOPES OF 35°, PROMINENT PROW, SCRUBBED BASALT ON ALL SIDES, A 75-FOOT WATERFALL IN BASALT SCABLAND HALF A MILE WEST OF IT.

GLACIAL WATERS IN WILLOW CREEK VALLEY BELOW LACROSSE HADNT SUFFICIENT GRADIENT TO DEVELOP SCABLAND. DEPOSITION OCCURRED INSTEAD. BUT SCABLAND IN THE VALLEY USED BY RR NORTHEAST OF LACROSSE AND NORTH OF UNION FLAT CREEK TO ROCK LAKE IS A WONDERFUL REGION OF RUGGED SCABLAND, IN CHANNELS AMONG PALOUSE HILLS OR IN BROAD TRACTS WITH ISOLATED PALOUSE HILLS. EVERY FEATURE WHICH CHARACTERIZES SCABLAND OR PALOUSE HILLS SEEMS AT MAXIMUM DEVELOPMENT HERE. SLOPES OF THE MARGINING PALOUSE HILLS AS STEEP AS 35° HILLS AS MUCH AS 200 FEET HIGH, WITHOUT A LEDGE OF BASALT SHOWING. MATURE TOPOGRAPHY IN FINE FORM, WITH SUFFICIENT RELIEF TO SHOW WELL BUT WITH LITTLE ENOUGH TO BE SET OFF SHARPLY FROM THE STEEPENED SLOPES MARGINING THE SCABLANDS.

PALOUSE RIVER VALLEY AT AND NEAR WINONA APPEARS TO HAVE BEEN FULLY AS DEEP IN PRE-SPOKANE TIMES AS IT NOW IS. THE EVIDENCE IS IN THE CHARACTER OF TWO TRIB. SCABLAND VALLEYS FROM THE NORTH, EACH OF WHICH HAD A WATERFALL OF 100 FEET OR SO TO REACH THE MAIN VALLEY FLOOR AND EACH OF WHICH SAW RETREAT OF THAT WATERFALL AND PRODUCTION OF A CANYON NEARLY A MILE LONG. FURTHER EVIDENCE FOR THE SAME CONCLUSION IS THE WIDTH OF PALOUSE VALLEY BOTTOM AND THE LARGE AMOUNT OF GRAVEL SPREAD OVER IT.

WINONA TO COLFAX TO PULLMAN TO LEWISTON TO MOSCOW TO OAKESDALE TO SPOKANE AUG 23-24 1923

NO NEW ELEMENTS OR INTERPRETATIONS SAVE TWO. NO TRACE OF GLACIAL WATERS.

(1) THE PROBLEM OF THE TWO CYCLES OF EROSION

(2) THE STRUCTURAL CONTROL OF THE DRAINAGE PATTERN

BOTH OF THESE SUBJECTS WRITTEN UP UNDER DATE OF AUG 31

IN NO GLACIATION SINCE THE PALOUSE MATURE TOPOGRAPHY WAS FORMED, OR EVEN SINCE THE PALOUSE LOESS (OR RESIDUAL SOIL) ACCUMULATED, HAS COEUR D'ALENE VALLEY (HEAD OF SPOKANE RIVER) BEEN DAMMED BY GLACIAL ICE TO CAUSE SOUTHWARD ESCAPE. HOW HIGH IS THE LOWEST PASS SOUTH OF THE LAKE? SEE RR ELEVATIONS.

HOW DID CORDILLERAN WATERS REACH THE SCABLANDS AT THE MAXIMUM EXTENT OF THE SPANGLE LOBE? MICA CHANNEL AND PINE CREEK CHANNEL INADEQUATE. MUST HAVE GONE OVER OR UNDER THE SPANGLE LOBE COULD NOT HAVE GONE OVER AND CROSSED THE LATAH LAKE PINE CREEK ROUTE. MUST HAVE GONE UNDER.

OR WAS THERE NO SPANGEE LOBE? AND WAS THE PALOUSE SOIL ON THE BASALT SOUTH OF MARSHALL HIGH ENOUGH TO CAUSE A SHORT-TIME DEFLECTION OF SOME OF THE WATER BY WAY OF PINE CREEK? BASALT SURFACE SOUTH OF MARSHALL NOW 2200+ SEE MAP. PINE CREEK-LATAH CREEK COL IS 2400+ FARRINGTON (FISH) LAKE PROBABLY THE LOWEST PLACE SOUTH OF MARSHALL. PALOUSE SOIL ON BASALT SOUTH OF MARSHALL THICK ENOUGH, IN LOWEST PLACES, ADDED TO DEPTH OF WATER, MIGHT RAISE LEVEL OF PONDED WATER HIGH ENOUGH TO CROSS PALOUSE SOIL TOPOGRAPHY FORMERLY ON SITE OF PRESENT SCABLAND COL. THIS SEEMS POSSIBLE BUT IMPROBABLE.

AND BY THIS HYPOTHESIS, STANDING WATER NORTH OF MICA PASS WOULD HAVE BEEN NO HIGHER THAN IN LATAH LAKE SOUTH OF IT. NO DISCHARGE ACROSS THEREFORE AND THE ONLY WAY TO GET THE ERRATICS THERE IS TO FLOAT THEM IN SPOKANELAKE-LATAH LAKE, WHICH MUST THEREFORE HAVE BEEN HIGHER THAN THE MICA COL. SEE ALTITUDE OF HIGHEST ERRATICS FOUND AT MICA. THIS SEEMS POSSIBLE BUT IMPROBABLE. THE ABSENCE OF ANY TOPOGRAPHIC EVIDENCE OF EROSION BY A GLACIAL STREAM ACROSS THE MICA COL AND SOUTH OF IT IS IN HARMONY WITH THIS VIEW, HOWEVER.

FURTHERMORE, WHAT ABOUT THE LARGE GRANITE BOULDERS OF DECOMPOSITION IN THE PANTOPS DEPOSIT? THEY SEEM TO DEMAND THE PRESENCE OF GLACAL ICE AGAINST MORAN HILL ON THE NORTH. ALL TOLD, IT SEEMS BETTER TO PUT THE CORDILLERAN WATERS UNDER THE SPANGLE LOBE, JUST AS OHIO RIVER MUST HAVE FLOWED UNDER THE CINCINNATI LOBE WHEN GLACIAL ICE REACHED 20 MILES OVER INTO KENTUCKY AND YET NO DIVERSION OF THE OHIO SOUTWARD AROUND IT OCCURRED.

LITTLE SPOKANE VALLEY AND MT. SPOKANE AUG. 25

THO THERE IS PLENTY OF EVIDENCE OF THE PRESENCE OF SPOKANE ICE IN THE VALLEY OF THE LITTLE SPOKANE, NOTHING OF FOREIGN MATERIAL WAS SEEN ON MT SPOKANE ABOVE THE LEVEL OF THE COLUMBIA BASALT; ABOUT 2000 ONLY THE ARKOSIC DEBRIS OF THE GRANITE TO THE SUMMIT. AND PLENTY OF SHALLOW CUTS ALONG THE NEWLY CONSTRUCTED AUTO ROAD.

NOR IS THERE ANY EVIDENCE, SEEN FROM THE SUMMIT, OF GLACIATION IN THE TOPOGRAPHY OF THE MT RANGE IN WHICH MT. SPOKANE STANDS. IT MUST BE CONCLUDED FFOM SEVERAL LINES OF EVIDENCE THAT NEITHER SPOKANE NOR WISCONSIN ICE EVER INVADED OR DEVELOPED IN THESE MTS OR EVER FILLED THE SPOKANE VALLEY SOUTH OF THEM.

THE LITTLE SPOKANE VALLEY LEADS SOUTH TO THE SPOKANE VALLEY BETWEEN PLEASANT PRAIRIE AND FIVE-MILE PRAIRIE. BUT THE STREAM GOES WEST TO JOIN THE MAIN VALLEY NORTH OF FIVE-MILE, AND THE WISCONSIN VALLEY TRAINS OF BOTH THE MAIN AND TRIBUTARY ARE ABOUT 200 FT LOWER (SEE EARLIER NOTES FOR FIGURE) THAN THE LIDGERWOOD-HILLYARD GRAVEL FILL. THIS FILL IS INTERPRETED AS OF SPOKANE AGE. ITS ALTITUDE SHOULD CORRESPOND TO THAT OF THE MARSHALL DELTA OR BE BUT LITTLE ABOVE IT. THE LITTLE SPOKANE, AFTER THE SPOKANE GLACIATION, WAS DIVERTED TO ITS PRESENT ROUTE AND THE WISCONSIN AGGRADATION FAILED TO completely FILL THE VALLEYS OF TRIB AND MAIN WHICH HAD BEEN ERODED DURING THE INTERGLACIAL INTERVAL. THIS FAILURE WAS BECAUSE GRAND COULEE WAS NEVER COMPLETELY BLOCKED BY THE WISCONSIN ICE.

IS PEONE PRAIRIE A PART OF THE SPOKANE V.T.?

NO TRACES OF A SPOKANE V.T. IN THE BIG RATHDRUM PRAIRIE VALLEY OR SPOKANE VALLEY EAST OF THE CITY. THIS IS PUZZLING. THERE SHOULD BE SOME REMNANTS. IT SEEMS EXPLICABLE ONLY ON THE CONCEPTION THAT SPOKANE ICE NEVER BUILT A V.T. SOUTWARD FROM LAKE PEND O'REILLE REGION. IF A LAKE EXISTED THERE (LAKE SPOKANE) THE GRAVELS MIGHT NOT GET THAT FAR, ESPECIALLY IF THE SPOKANE ICE FAILED TO REACH VERY FAR SOUTH IN THE VALLEYS OPENING SOUTH OF CLARKS FORK.

NEWPORT— SANDPOINT— COCOLALLA AUG. 26

A BIG V.T. IN TERRACE REMNANTS AT NEWPORT. MUCH LIKE THE SPOKANE V.T. BELOW THE CITY. BUT IT DOESNT EXTEND EASTWARD. INSTEAD, THERE IS PLENTY OF EVIDENCE IN THE BARE OR THINLY COVERED ROUNDED LOWER HILLS AND LEDGES THAT GLACIAL ICE COVERED THEM WHEN THE V.T. WAS OF CLARKS FORK WAS DEPOSTIED.

THE SAME BARE, OR THINLY COVERED, ROUNDED LEDGES ARE VERY CONSPICUOUS IN COCOLALLA VALLEY AS FAR SOUTH AS CAREYWOOD. MANY ROADSIDE SECTIONS SHOW TILL ALSO. NEAR CAREYWOOD ARE LOW HILLS WHICH APPEAR TO BE MORAINIC. AND A FEW MILES FARTHER SOUTH BEGINS THE GREAT RATHDRUM PRAIRIE FILL, A PART OF THE WISCONSIN V.T. OF THE SPOKANE VALLEY. WISCONSIN ICE THEREFORE PROBABLY NEVER REACHED SOUTH OF CAREYWOOD OR THE SOUTH END OF PEND O'REILLE LAKE, OR WEST OF NEWPORT.

COLUMBIA BASALT IN THE VALLEYS EAST OF SPOKANE AUG 26

LARGE LEDGES WEST OF LONE MTN AND NORTH OF HAYDEN LAKE, SHOWN ON TOPOGRAPHYC MAP. ALSO ABOUT NORTH END OF COEUR D'ALENE LAKE AND WOLF LODGE BAY., LIKEWISE SHOWN ON MAP. ALTITUDE OF SURFACES 2500 TO 2700 CLEARLY THE COLUMBIA BASALT FOMND THESE VALLEYS ALREADY HERE, AND THE COEUR D'ALENE MTS, MUCH AS THEY ARE TODAY, WERE HERE IN MIOCENE TIMES.

SIGNIFICANCE OF BARS, INSTEAD OF TERRACE REMNANTS, IN THE SCABLANDS.

A GRAVEL FILL OF GREAT DEPTH MAY BE THE WORK OF A SMALL STREAM IN A CAPACIOUS VALLEY THRU A LONG TIME. TERRACES LEFT BY DISSECTION OF SUCH A FILL DO NOT INDICATE THE PRESENCE OF A LARGE STREAM IN THEIR PRODUCTION. MEANDERING IS A MORE PROBABLE ASSUMPTION FOR THE WIDTH OF THE EXCAVATED TRACTS.

BUT BARS, INSTEAD OF TERRACE FRAGMENTS, INDICATE CLEARLY THE PRESENCE OF A STREAM DEEPER THAN THEY ARE THICK AND STRETCHING AT SUCH LEVEL CONTINUOUSLY ACROSS THE VALLEY. THE VALLEY IN SUCH CASE IS PROPERLY A CHANNEL.

THE TWO-CYCLE PROBLEM

BARABOO AUG. 31

HITHERTO THE CONCEPTION OF TWO CYCLES OF VALLEY CUTTING IN WHITMAN COUNTY HAS BEEN ARRIVED AT BY COMPARISON OF DIFFERENT VALLEYS IN THE PALOUSE RIVER SYSTEM. REBEL FLAT, SPRING FLAT, UNION FLAT, ETC. WERE CONSIDERED OLD VALLEYS OF THE FIRST CYCLE (ALL THE MINOR DRAINAGE LINES OF THE PALOUSE HILLS BELONG TO THE SAME CYCLE) WHILE THE CANYONS AT COLFAX AND ELSEWHERE WERE

CONSIDERED TO BELONG TO THE NEW CYCLE. ONLY AT COLFAX AND ABOVE, HAD THE YOUNG VALLEYS BEEN SEEN INCISED IN THE FLOOR OF THE OLD ONES.

LATER, DOUBT AROSE AS TO THE VALIDITY OF THE CONCEPTION. AN ALTERNATIVE INTERPRETATION WAS CONSIDERED;— THAT THE MATURE ASPECT WAS DUE TO EROSION IN THE LOESSIAL MATERIAL ABOVE THE BASALT, AND THE YOUTHFUL CANYONS WERE DUE WHOLLY TO THE GREATER RESISTANCE OF THE BASALT TO SLOPE WASH.

THE CRITERION OF GRADIENT WAS NOT APPLIED. IF REJUVENATION REALLY HAS OCCURRED, ROADS AND RAILROADS WHICH FOLLOW THE WHITMAN CO VALLEYS SHOULD SHOW A NOTEWORTHY DECREASE IN GRADIENT AS THEY EMERGE FROM THE CANYONED PORTION TO THE BROAD FLAT PORTION FARTHER UPSTREAM.

THE VALLEY OF REBEL FLAT CREEK WAS FOLLOWED FROM WINONA, WHERE IT JOINS THE PALOUSE VALLEY, TO THE HEAD. AT WINONA THE PALOUSE VALLEY HAS SOME BASALT CLIFFS ANTEDATING THE SPOKANE FLOODS AND REBEL CREEK VALLEY JOINS IT AT ACCORDANT GRADE, WITH A NARROW, STEEP-WALLED VALLEY IN WHICH BASALT LEDGES SHOW, THO IT IS NOT STRICTLY A CANYON. THE MATURE TOPOGRAPHY CHARACTERISES ALL THE UPLANDS ABOUT THIS JUNCTION, EXCEPT WHERE THE LATER SCABLANDS OCCUR. IN SUCH A SITUATION, IT IS EASY TO SEE TWO CYCLES.

BUT THE TRAVERSE UP REBEL FLAT CREEK SHOWED VIRTUALLY NO CHANGE IN GRADIENT, NO NARROWING OF THE YOUNGER-LOOKING, LOWER PART AND NO RAVINE HEAD INCISED IN THE FLAT. THERE APPEARS TO BE A CONTINUOUS NORMAL GRADIENT ALL THE WAY FROM WINONA TO THE HEAD. THE NARROWNESS OF THE LOWER VALLEY AND THE STEEPNESS OF ITS WALLS APPEAR TO BE DUE WHOLLY TO THE GREATER RESISTANCE OF THE BASALT TO SLOPE WASH AND LATERAL PLANATION.

THIS CONCLUSION HARMONIZES WITH THE CONDITIONS IN ALKALI CREEK VALLEY, ABOVE RIPARIA, WHERE THERE IS A NORMAL STREAM GRADIENT ALL THE WAY FROM THE BOTTOM OF SNAKE RIVER VALLEY TO THE SUMMIT OF THE PLATEAU. SURELY, IF TWO CYCLES ARE TO BE FOUND IN ANY VALLEYS, THEY SHOULD BE FOUND RECORDED IN THE GRADIENT OF SUCH A STREAM, FOR IT HAS MUCH THE BEST OPPORTUNITY FOR CUTTING A SECOND CYCLE CANYON.

IT IS THEREFORE CONCLUDED THAT THE APPARENT TWO CYCLE VALLEYS DEPEND ON THE HIGHLY CONTRASTED CHARACTER OF THE TWO FORMATIONS, THE LOESS AND THE BASALT. THERE HAS BEEN NO UPLIFT TO CAUSE THIS DIFFERENCE.

AN ITEM WHICH AT FIRST SIGHT DOES NOT SEEM TO AGREE WITH THE ABOVE CONCLUSION IS THE FACT THAT THE PALOUSE HILLS EAST OF THE SCABLANDS HAVE BASES OF BASALT, I.E. THE MATURE VALLEYS ARE ERODED SOMEWHAT IN BASALT. BUT ISNT THIS A MATTER OF THE SURFICIAL DISINTEGRATION OF THE BASALT BELOW THE LOESS? IF IT IS, THIS ITEM DOES NOT MILLTATE AGAINST THE CONCEPTION ABOVE ADVANCED.

ANOTHER ITEM IN THIS PROBLEM FLOWS FROM THE STRUCTURAL CONTROL OF THE DRAINAGE PATTERN IN THE SOUTHERN PART OF WHITMAN CO. IT WILL BE DISCUSSED UNDER THAT HEADING.

STRUCTURAL CONTROL OF THE DRAINAGE PATTERN IN SOUTHERN WHITMAN COUNTY ANDELSEWHERE

BARABOO AUG. 31

RUSSELL ONCE NOTED THE PARALLELISM IN THE DRAINAGE LINES OF THIS PART OF THE PLATEAU OF WASHINGTON. IT IS WELL SHOWN IN UNION FLAT CREEK, PALOUSE RIVER, REBEL FLAT CREEK, SPRING FLAT VALLEY, ALKALI CREEK VALLEY, SNAKE RIVER VALLEY AND SEVERAL STREAMS SOUTH OF THE SNAKE. THEY ALL LIE CLOSE TO EACH OTHER AND SWING IN GREAT, RUDELY CONCENTRIC CORVES WHOSE CONVEXITY IS TOWARD THE NORTH. THAT IS, THEY ALL FLOW NW, THEN W, THEN SW

A STRUCTURAL CONTROL WAS SUSPECTED AFTER THE DRAINAGE PATTERN IMMEDIATELY NORTH AND SOUTH OF WASHTUNCA COULEE WAS FOUND TO BE SO DETERMINED. IT BECAME A CONVICTION AFTER SNAKE RIVER VALLEY AT LEWISTON AND CLARKSTON HAD BEEN SEEN.

SNAKE RIVER AT LEWISTON FLOWS IN A GREAT SYNCLINE, WITH MUCH STEEPER NORTHERN LIMB. THE FAMED LEWISTON GRADE, BY WHICH THE HIWAY DESCENDS FROM THE WHITMAN CO PLATEAU TO THE RIVER, IS CONSTRUCTED ON THIS SOMEWHAT ERODED NORTHERN SLOPE. THE BASALT EXPOSED IN CUTS IS TILTED SOUTHWARD AND IN MANY PLACES IS BRECCIATED AND SLICKENED AND ALL TRACES OF COLUMNAR STRUCTURE DESTROYED. WEST OF THIS GRADE A MILE OR SO ARE GOOD HOGBACKS OF TILTED BASALT FLOWS. THE STRIKE OF THIS NORTHERN LIMB IS ABOUT N 75°E, AND THE DIP ON THE PROMINENT HOGBACKS IS 21° SWARD. ALTITUDE AT TOP OF THE GRADE IS 2750, AT THE BOTTOM IT IS 750. IN THIS DESCENT OF 2000 FT THE HIGHWAY WINDS AMAZINGLY. TEN MILES OF ROADWAY ARE NECESSARY TO GO FROM THE SUMMIT OF THE GRADE TO THE FOOT, A HORIZONTAL DISTANCE ON THE MAP OF TWO MILES.

SNAKE RIVER AND CLEARWATER RIVER HAVE CUT 450 FEET INTO THE FLOOR OF THIS SYNCLINE. THE SNAKE ENTERS THE SYNCLINE FROM THE SOUTH, THE CLEARWATER NEAR LEWISTON FLOWS ESSENTIALLY ALONG THE AXIS. BELOW THE JUNCTION OF THE TWO STREAMS, THE SNAKE FLOWS ALONG THE AXIS FOR SOME MILES.

PROBABLY NOT 100 FT OF BASALT HAS BEEN REMOVED FROM THE HILLTOPS ON THE PLATEAU TO THE NORTH— THE STRUCTURAL DESCENT HERE IS THEREFORE ABOUT 1750 FT.

THE SOUTHERN LIMB OF THE SYNCLINE HAS A MUCH MORE GENTLE SLOPE. INSTEAD OF TWO MILES HORIZ— ONTAL IN DIP DIRECTION FROM EDGE TO AXIS, THERE ARE AT LEAST 15 MILES, PERHAPS 20 MILES OR MORE. ON THIS LONG SLOPE ARE SEVERAL STRUCTURAL TERRACES, SEPARATED BY STRUCTURAL SLOPES. ONE OF THESE TERRACES BEARS ORCHARD TRACTS WHICH COULD NEVER HAVE BEEN ESTABLISHED AND IRRIGATED HAD NOT THE STRUCTURAL FLAT BEEN PRESENT.

THAT THIS VALLEY AT THE JCT OF SNAKE AND CLEARWATER RIVERS IS NOT EROSIONAL IS EVIDENT. THE VALLEY OF SNAKE RIVER IN ENTERING THE SYNCLINE IS A NARROW, STEEP—WALLED CANYON, DEEPER IN THE UPDIP DIRECTION AND WHOLLY UNLIKE THE GREAT CAPACIOUS VALLEY AT LEWISTON—CLARKSTON.

THE SURFACE OF THE COLUMBIA BASALT AT THE CROSSING OF THE WASH—IDAHO LINE AND SNAKE RIVER IS THEREFORE THROWN INTO A MAJOR FOLD, COMPARABLE IN MAGNITUDE TO ANY OTHER FOLDS OF THE PLATEAU, OR ANY OF THE CASCADE MT SPURS SAVE BADGER MT. WEST OF THE COLUMBIA. BUT IT IS A DOWNFOLD, NOT AN UPFOLD. IT IS ASYMMETRICAL, AS ARE PRACTICALLY ALL THE GREAT FOLDS OF THE PLATEAU. THERE ARE NO ACCOMPANYING GREAT UPFOLDS, THO SEVERAL MINOR ONES EXIST.

WITH THIS EVIDENCE OF FOLDING IN THE PLATEAU, CONTROLLING THE GREAT DRAINAGE LINE OF THE PLATEAU, IT BECOMES NECESSARY TO APPLY THE SAME HYPOTHESIS TO THE CURVILINEAR DRAINAGE OF THE MINOR STREAMS. THIS MUST ALL BE WORKED OUT IN TERMS OF TOPOGRAPHY FOR THERE ARE NO SECTIONS IN THE BASALT TO SHOW STRUCTURE. BUT SINCE TOPOGRAPHY IS SO STRIKINGLY CONTROLLED BY

BY STRUCTURE, DESPITE THE PRESENCE OF THE LARGEST STREAM CROSSING THE COLUMBIA PLATEAU, IT IS A SAFE GUIDE. IN THE FIELD, AND ON THE TOPOGRAPHIC MAP, IT IS CLEAR THAT THE DIVIDES SEPARATING THESE CLOSELY SPACED CURVILINEAR STREAMS ARE ANTICLINAL, AND ARE HIGHER THAN THE UNWARPED SURFACE IN THE NORTHERN PART OF WHITMAN CO AND ABOUT MOSCOW. THE STREAMS THEREFORE FLOW IN SHALLOW SYNCLINES AND ARE MUCH LONGER IN PROPORTION TO THEIR DRAINAGE AREA THAN THEY WOULD BE IN A NORMAL DENDRITIC PATTERN.

THE "FLATS" OF UNION CREEK, REBEL CREEK, ETC., ARE THEREFORE NOT EROSIONAL VALLEYS SO MUCH AS THEY ARE STRUCTURAL. THE MATURE TOPOGRAPHY OF THE PALOUSE HILLS HAS BEEN DEVELOPED WITH RELATIVE RAPIDITY IN THE LOESS AND THE DECAYED UPPER PART OF THE BASALT, BEFORE THE TRENCHING OF THE PLATEAU BASALT BY THE MAJOR STREAMS HAS REACHED BACK INTO THE REGION. THE CANYONS AND STEEP-WALLED VALLEYS THEREFORE DATE BACK AS FAR AS THE MATURE MINOR VALLEYS. THE VALLEY DEVELOPMENT BEGAN AT BOTH ENDS, AT THE HEADS ON THE ANTICLINAL UPLIFTS AND AT THE MOUTHS ON THE MARGINS OF THE PLATEAU. THE "FLATS" ARE NOT PARTS OF THE EROSIONAL TOPOGRAPHY.