DAVID BLOOM

Precambrian Sedimentary Environments of the Death Valley Region, Eastern California

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INTRODUCTION

Noteworthy among the geologic features of the Death Valley region of eastern California is an extensively exposed accumulation of sedimentary rock and sill-forming diabase, Precambrian in age, as much as 5,500 m thick, and essentially unmetamorphosed. Although these rocks have yet to yield a reliable radiometric date, the oldest probably were deposited about 1.4 b.y. ago, as they rest with profound unconformity upon a crystalline complex from which 1.7-b.y. dates have been obtained, and they have been intruded by diabase sills and dikes that seem best correlated with similarly disposed diabase bodies, of central and southern Arizona, that are about 1.2 b.y. old. The youngest Precambrian strata of the Death Valley region conformably underlie strata that contain Early Cambrian fossils.

This Precambrian section has long been recognized as composed of (1) a lower succession, named the Pahrump Group and referred to by some as "Beltian" in age, and (2) an upper succession divided into several formations (Fig. 1) comparable in stratigraphic position with the Windermere Group of the more northerly parts of the North American Cordillera.

The two successions were originally defined as separated by an angular unconformity beneath the Noonday Dolomite (Noble, 1934; Hazzard, 1937; Hewett, 1956). The unconformity causes the Noonday to rest variously upon each of three formations of the Pahrump Group and upon the older crystalline complex. Most workers in the region have assumed that somewhere in this impressive accumulation of sedimentary units and sills is recorded a change in provenance from one that was initiated with the beginning of Pahrump sedimentation and has remained little understood, to another that constitutes the provenance of the Cordilleran miogeosyncline. The sub-Noonday unconformity has frequently been inferred to be the principal indicator of this change, so that published stratigraphic cross sections of the southern part of the Cordilleran miogeosyncline consistently show the Noonday as the lowest formation in it. Not everyone has accepted this interpretation, however, partly because carbonate rock rarely forms the initial deposit in a developing miogeosynclinal environment. Noble (1941, p. 592) observed that the entire Johnnie Formation, which overlies the Noonday, is lithologically more similar to parts of the Pahrump Group than to any of the younger formations, and on many occasions, he informally expressed the belief that the deposition of the enormous volume of detrital silica preserved in the Stirling Quartzite marked the initiation of the miogeosyncline. Stewart (1972), on the other hand, has suggested that the change in provenance is recorded in the pre-Noonday conglomeratic units, commonly diamictite, of the Kingston Peak Formation, and he proposed that they were deposited on a continental shelf.

We will briefly summarize data, much of it recently acquired and described more completely elsewhere in this volume, that relates to the nature of sedimentary environments that existed before the beginning of the Cordilleran miogeosyncline. These data indicate that the occurrences of the Pahrump Group in the southern Death Valley region were deposited within a long-continuing west-northwest-trending trough or basin (Figs. 2 and 3) about 50 km wide and at least 100 km long, with bordering platform areas that at times were inundated by shallow seas and at other times stood well above sea level to become source areas of basinal clastic sediments. The structural and stratigraphic characteristics of this feature suggest that it is an aulacogen precisely in the sense that aulacogens are defined and characterized in a recent review by Hoffman and others (1974). As indicated by them, aulacogens were recognized by the Russian geologist Shatiski and consist of "long-lived, deeply subsiding troughs, at times fault-bounded, that extend at high angles from geosynclines far into adjacent foreland platforms." The trough that controlled Pahrump and subsequent sedimentation is named by us the Amargosa aulacogen. Its bordering, generally high areas to the north and south we designate as the Nopah (Wright and Troxel, 1967) and the Mojave uplands, respectively (Fig. 3B).

As the Noonday Dolomite passes abruptly southward into time-equivalent basinal deposits that are approximately coextensive with basinal units of the underlying Pahrump Group, we view the Noonday and its equivalent units as deposited within the provenance of the Amargosa aulacogen rather than within the Cordilleran miogeosyncline. The sub-Noonday unconformity we attribute to strong post-Pahrump emergence along the northern margin of the aulacogen. Thus interpreted, the Noonday Dolomite marks a carbonate platform developed on the deeply eroded edge of a trough.

We also observe evidence that the overlying Johnnie Formation and Stirling Quartzite were deposited on a south to south-southwesterly paleoslope, tectonically perpetuated since the beginning of Pahrump time, and that the northwesterly paleoslope, which seems to have characterized the part of the miogeosyncline that occupied the site of the southern Death Valley region, became firmly established with the deposition of the Wood Canyon Formation. The uplift of the Nopah upland apparently recurred briefly and finally to produce a southwesterly paleoslope upon which were deposited arkosic strata in the lower part of the middle members of the Wood Canyon (Diehl, this volume).

The existence of the depositional trough and the west-northwest orientation of its axis is indicated in numerous stratigraphic and sedimentologic features of the three Pahrump formations and the Noonday. Isopachous lines drawn on these formations collectively, on each formation, and on most individual members display a troughlike configuration. With respect to this configuration, deep-water facies, where present in the section, occupy the center of the trough; some carbonate units intertongue with siliceous clastic strata near the margins; clastic units of various types fine troughward or from one side of the trough to the other; and various current direction features indicate paleoslope directions consistent with a west-northwest-trending trough. Changes in facies and thickness are characteristically abrupt and commonly occur on either side of mappable faults or monoclines. The formation of the trough is thus largely attributable to vertical

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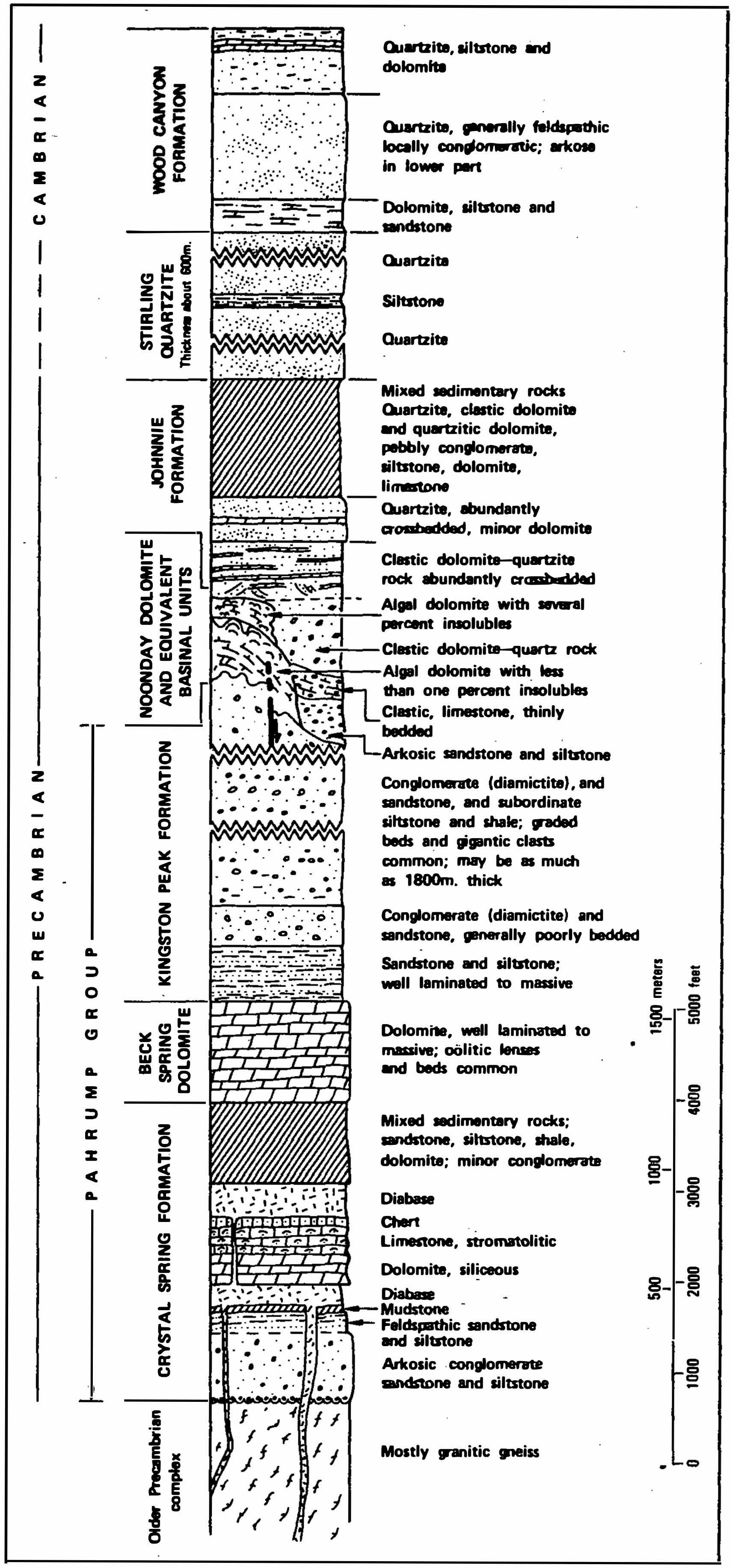
Figure 1. Generalized columnar section of Precambrian to Lower Cambrian strata, Death Valley region.



movements on fault-bounded blocks. The lower part of the Kingston Peak Formation, on the other hand, probably was deposited while the earlier underlying strata were being folded into a broad downwarp. This relationship is indicated in a somewhat idealized fashion in the stratigraphic-structural cross section in Figure 2.

NOPAH UPLAND

The northerly margin of the trough was first detected in the reconstruction of paleogeologic contacts on the sub-Noonday surface (Wright and Troxel, 1967; Fig. 3C, this paper). Their configuration indicates that, prior to the deposition of the Noonday Dolomite, an uplifted positive area of crystalline rocks extended from the present Black Mountains for at least 100 km eastward and was flanked southward by progressively younger units of the Pahrump Group. Additional evidence for the uplift and for the conclusion that the two lower formations of the Pahrump Group, namely the Crystal Spring Formation and the Beck Spring Dolomite, once extended northward into the area of crystalline rocks on the paleogeologic map and were eroded away in pre-Noonday time (Wright and Troxel, 1967), is contained in the observations that Crystal Spring and Beck Spring debris is abundant in the conglomeratic units of the Kingston Peak Formation and that the debris was transported southward (Troxel, 1967).

Other observations, made subsequently, indicate that this northerly positive area and the south to south-southwesterly paleoslope were in existence when the earliest of the Pahrump strata were deposited and that they persisted through all of Pahrump time. Roberts (this volume) has shown, for example, that the Crystal Spring Formation displays (1) a southward fining in average grain size and in maximum size of clasts in the sandstone-conglomerate arkosic strata that compose its lower part, and (2) a general south-southwest orientation of cross-bedding in conglomeratic strata in that unit (Fig. 3D). The Beck Spring Dolomite, which in the central part of the trough is free of siliceous detrital beds, contains two tongues of fine-grained quartzite in exposures along the indicated site of the basin margin immediately south of Ashford Canyon on the west face of the Black Mountains (L. A. Wright and B. W. Troxel, unpub. data).

The Kingston Peak Formation, which remains to be studied in detail, shows evidence of the Nopah upland by a marked northward thinning (Fig. 4A), as well as by its content of debris derived from the Crystal Spring Formation and Beck Spring Dolomite. The thinning is well displayed in exposures (1) in the Black Mountains north of the highway between Jubilee Pass and the Ashford Mill site (L. A. Wright and B. W. Troxel, 1974, unpub. data), (2) in the Alexander Hills at the south end of Nopah Range (Wright, 1973), and (3) in the vicinity of the Excelsior talc mine on the northeastern side of the Kingston Range (Wright, 1968). It is caused in part by erosion that preceded the deposition of the Noonday Dolomite, in part by the fact that some units that were deposited in the central part of the basin were not received by the topographically higher fault blocks along the margins of the basin, and in part by a stratigraphic thinning of individual units (Fig. 2).

The southward change in facies of the Noonday Dolomite,

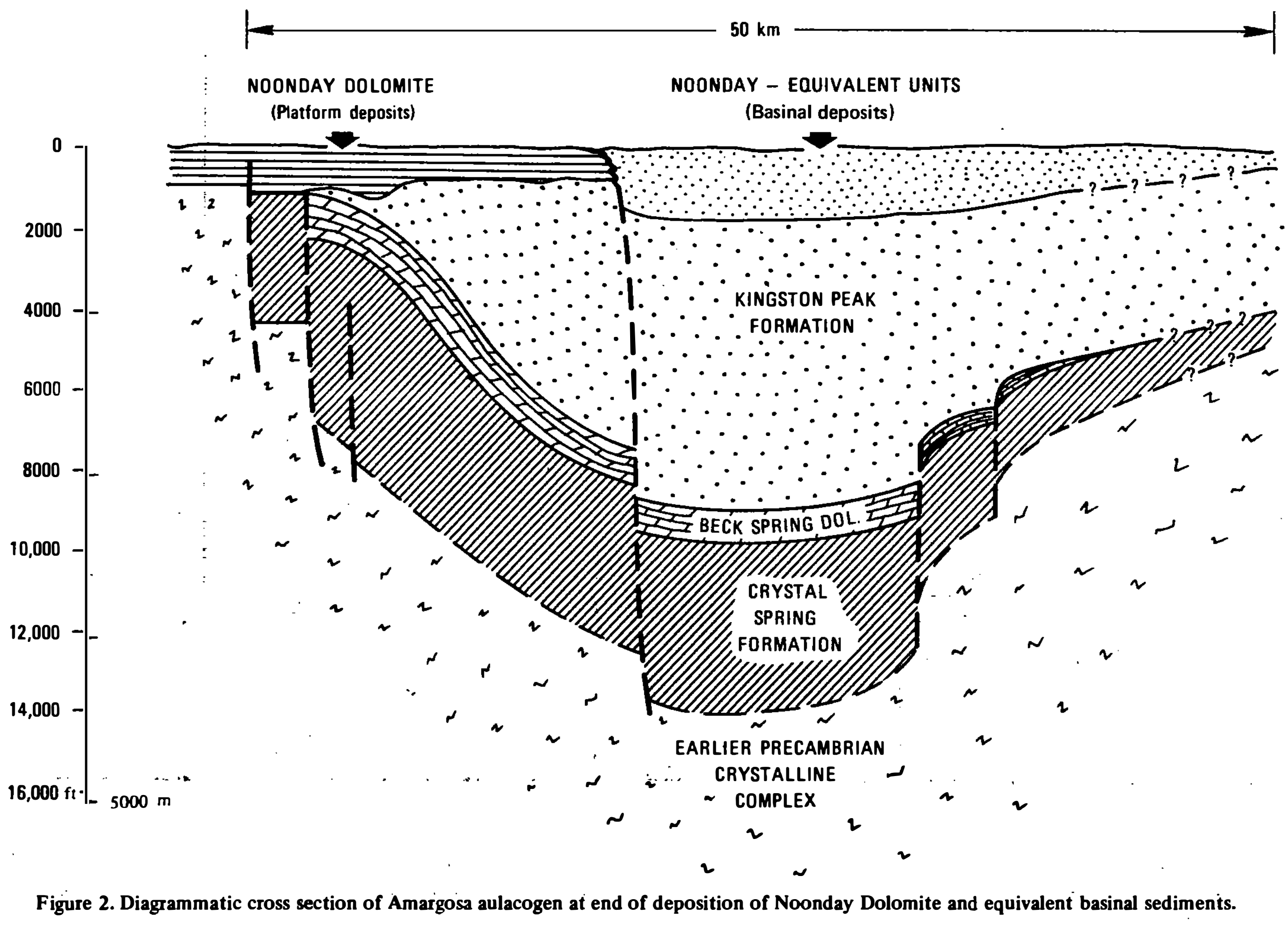


Figure 2. Diagrammatic cross section of Amargosa aulacogen at end of deposition of Noonday Dolomite and equivalent basinal sediments.

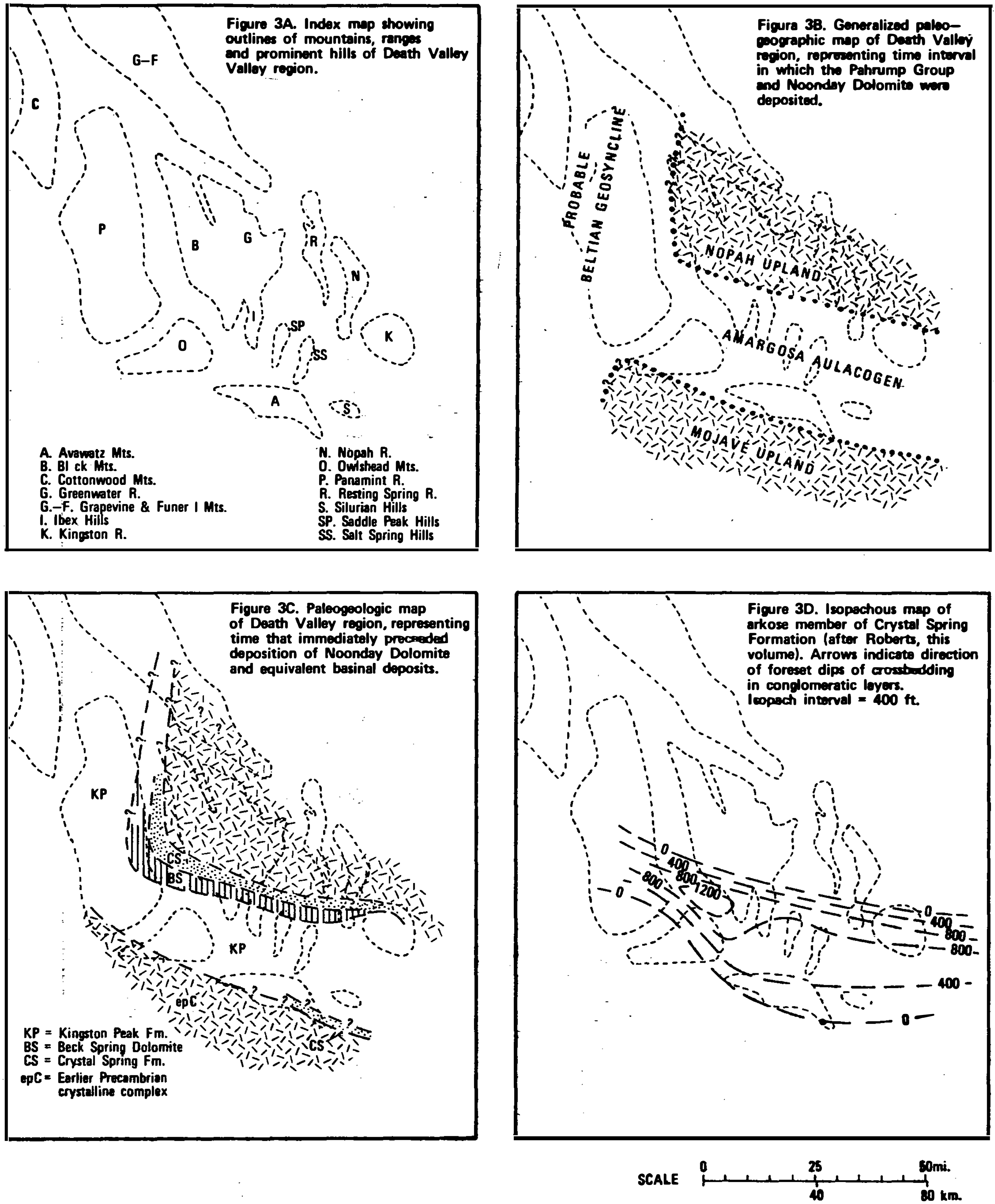


Figure 3A. Index map showing outlines of mountains, ranges and prominent hills of Death Valley Valley region.

Figura 3B. Generalized paleogeographic map of Death Valley region, representing time interval in which the Pahrump Group and Noonday Dolomite were deposited.

Figure 3C. Paleogeologic map of Death Valley region, representing time that immediately preceeded deposition of Noonday Dolomite and equivalent basinal deposits.

Figure 3D. Isopachous map of arkose member of Crystal Spring Formation (after Roberts, this volume). Arrows indicate direction of foreset dips of crossbedding in conglomeratic layers. Isopach interval = 400 ft.

Figure 3. Paleogeographic maps of times when Pahramp Group and Noonday Dolomite were deposited, and isopachous map of Crystal Spring Formation.

from the platform carbonate to basinal strata (Williams and others, this volume), records a still later phase in the stratigraphic-tectonic development of the Amargosa aulacogen and its northern margin. The exposures of the Noonday that extend from the southwestern part of the Panamint Range for about 140 km south-southeastward (Figs. 2 and 4B) consist almost entirely of dolomite that has formed in the presence of algal mats. At various localities these platform deposits, which ordinarily are 200 m or less thick, can be traced abruptly into basin deposits two to three times as thick. The latter are composed, in upward succession, of arkosic sandstone and siltstone in which graded bedding is common, thinly bedded clastic limestone, and an almost structureless detrital unit composed of dolomite and quartz. Clastic dolomite and quartz also compose a strongly cross-bedded sandstone unit that overlies both the dolomite of the platform and the structureless unit of the basin and marks the transition from the Noonday Dolomite and equivalent units into the overlying Johnnie Formation.

A northerly to northeasterly source for the dolomite and quartz grains of the uppermost of the basinal units and the cross-bedded unit must be invoked to explain the intimate association of the two minerals, the quartz grains originating beyond the limits of the carbonate cover of the platform, passing over it, and mixing with detrital dolomite where the cover was being destroyed by wave or stream action. Measurements of current directions in the cross-bedded strata indicate a generally east-southeast strike for the paleoslope, essentially unchanged from the strike of the slope upon which the lowermost of the Pahrump strata were deposited. Indeed, measurements made to date of cross-bedding orientation in sandstone throughout the Johnnie Formation and Stirling Quartzite suggest that this strike persisted during the deposition of both (Fig. 4D). As these formations are exposed at various localities for many kilometers to the northeast of the basin, the source areas of the detrital material must have been much more distant from the basin site than the source areas of the detrital strata of the Pahrump units.

MOJAVE UPLAND

Evidence for exact location of the southern margin of the Amargosa aulacogen is less clear than that for the site of the northern margin, as Mesozoic and Cenozoic deformational and intrusive events have obscured the Precambrian record there. In the Silurian Hills, however, a conformable section of Pahrump strata, at least 2,220 m thick, has been identified (Kupfer, 1960; Wright and Troxel, 1966). The lower 300 m of this section is lithologically correlative with the lower and middle units of the Crystal Spring Formation as recognized elsewhere (Roberts, this volume). An apparently complete and thicker occurrence of the Crystal Spring also is exposed near the mouth of Sheep Creek Canyon on the north slope of the Avawatz Mountains. The distribution of a complex of post-Pahrump sedimentary units and Mesozoic(?) diorite, on either side of the valley that separates the Avawatz Mountains from the Silurian Hills, suggests right-lateral displacement of about 8 mi (13 km) and thus a strong possibility that these two Pahrump localities were once approximately opposite each other (Fig. 5D) on either side of the southern extension of Death Valley.

In spite of the paucity of exposures and intact sections, southward changes observable in the lithology of the Pahrump, from the central part of the basin to these two localities and at other intermediate localities, as well as the presence and lithology of the basinal strata that are the time equivalent of the Noonday Dolomite, indicate the existence of a southerly positive area from which much detritus was fed into the Amargosa aulacogen (Fig. 2).

The earliest evidence of a southerly tectonic high is the southward thinning of the shallow-water arkosic lower part of the Crystal Spring (Roberts, this volume; Fig. 2), although Roberts has concluded that most or all of this detritus was derived from the northern upland. Quartzite layers in the middle part of the Crystal Spring Formation in the Silurian Hills (Kupfer, 1960) are interlayered with subordinate carbonate strata, the lower of which are dolomite and the upper of which are limestone. The clastic material is attributable to a southerly source. To the north, this part of the formation generally consists of two carbonate members, a lower member of siliceous dolomite and an upper limestone member containing stromatolites.

The higher part of the section in the Silurian Hills, as Kupfer (1960) observed, consists mostly of sandstone and conglomerate. Although he assigned the entire section to the Pahrump Group, he hesitated to make firm correlations with the established formations of the Pahrump, noting, however, that a limestone unit, about 30 m thick and about 780 m above the base of the section, may be correlative with the Beck Spring Dolomite. He also observed that, in general, the section of the Silurian Hills contains coarser clastic rocks than those farther north and a smaller proportion of carbonate material. He thus proposed a southerly source for the clastic material.

Subsequent observations of the more northerly of the Pahrump occurrences support Kupfer's observations and interpretations to the extent that they apply to the upper part of the Crystal Spring Formation and the Beck Spring Dolomite. In the Ibex-Saratoga Hills the Beck Spring Dolomite shows a marked southward increase in insoluble material in the form of shaly and sandy layers. The upper units of the Crystal Spring in the central and northern parts of the basin are distinctly finer grained and contain a higher proportion of carbonate material than do the strata beneath the aforementioned limestone unit in the Silurian Hills.

Although most of the clastic material in the Kingston Peak Formation is traceable to the northerly source area, Troxel (1967) has recognized a southern Kingston Peak facies which contains clasts of metamorphic rocks unlike those in the rest of the formation and apparently derived from the south (Fig. 4A). Troxel has since observed that the two facies intertongue in a more complex fashion than his published description implies.

A southern source area also is indicated for the unit of arkosic sandstone and siltstone in the succession of strata that forms the basinal equivalent of the Noonday Dolomite (Fig. 4B). As observed by Williams and others (this volume), this unit contains bottom markings that evidence northerly transport, displays a northerly fining, and, in its northernmost exposures, shows an on-lapping relationship with the lower dolomite of the platform. The Nopah upland, at that time, was a low area largely or entirely covered by carbonate rock and thus could not have provided detritus of arkosic composition.

Stratigraphic-Tectonic Environments of the Amargosa Aulacogen

In brief, the various stratigraphic and structural features of the Amargosa aulacogen record a history divisible into two superstages. Each is characterized by (1) an early period of erosion of the northern (Nopah) upland concurrent with clastic sedimentation in the subsiding trough, and (2) a later period of stability when that upland became a surface of low relief to serve as a platform and receive a cover of carbonate rocks. The southern (Mojave) upland apparently also was elevated with respect to sea level in two stages, one preceding and the other following the deposition of the Beck Spring–equivalent(?) unit of limestone in the Silurian Hills. These were approximately

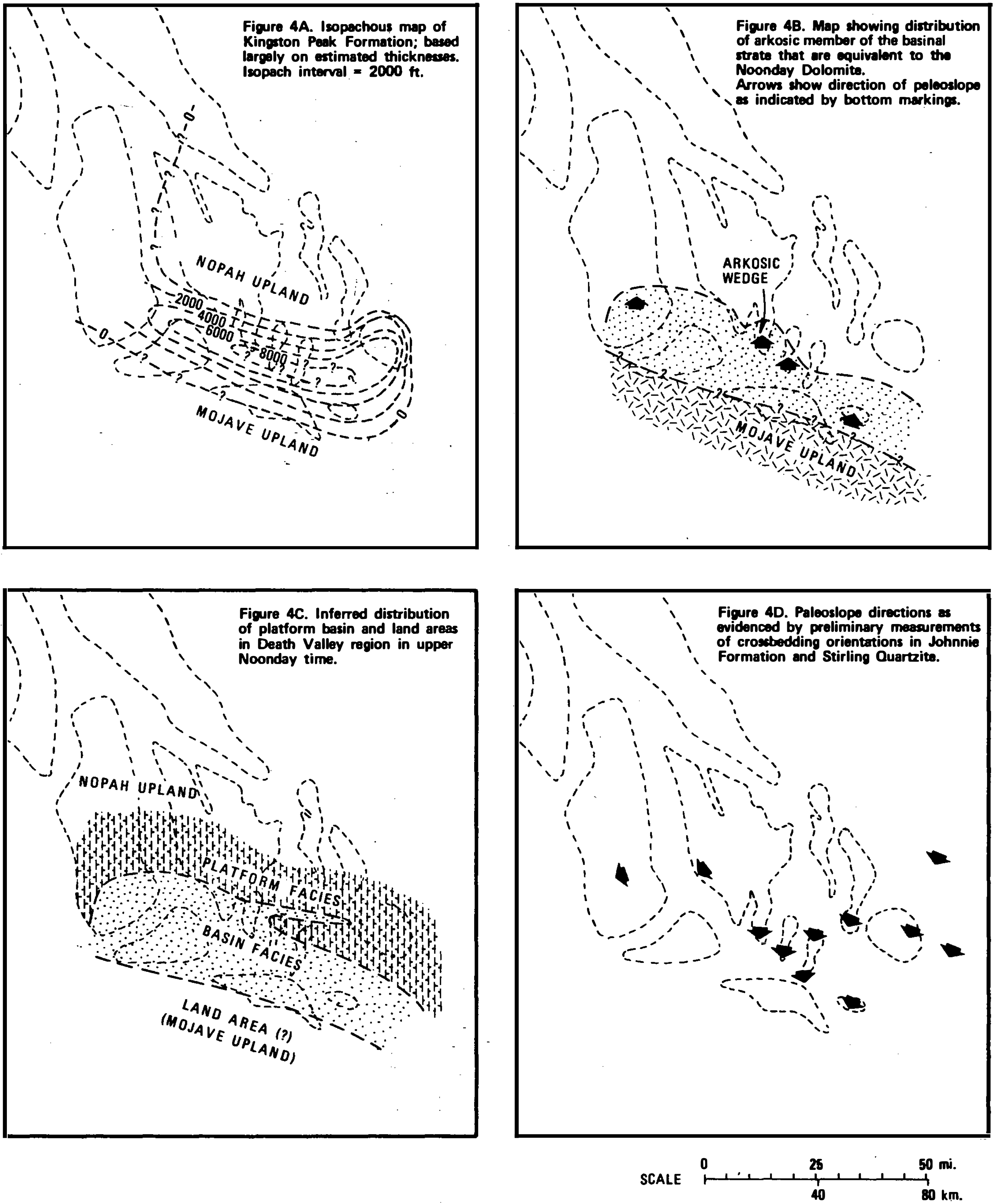


Figure 4A. Isopachous map of Kingston Peak Formation; based largely on estimated thicknesses. Isopach interval = 2000 ft.

Figure 4B. Map showing distribution of arkosic member of the basinal strata that are equivalent to the Noonday Dolomite. Arrows show direction of paleoslope as indicated by bottom markings.

Figure 4C. Inferred distribution of platform basin and land areas in Death Valley region in upper Noonday time.

Figure 4D. Paleoslope directions as evidenced by preliminary measurements of crossbedding orientations in Johnnie Formation and Stirling Quartzite.

Figure 4. Isopachous map of Kingston Peak Formation, distribution map of Noonday Dolomite and equivalent basinal facies, and paleoslope directions of Johnnie and Stirling, Death Valley region. See Figure 3a for identification of mountains.

concurrent with the two erosional periods of the Nopah upland. But the trough received detritus from the northerly source considerably earlier than it did from the southerly source. The latter, however, may then have remained continually above sea level and, almost continually, a source area for clastic sediment. If it did, at times, receive carbonate platform deposits, a record of the covering remains unobserved either in situ or in the basinal detritus.

The two stages, although grossly similar, differed from each other in several major respects. The first stage, as recorded in the sediments of the Crystal Spring Formation and Beck Spring Dolomite, was featured by relatively slow subsidence compared with the subsidence rate during the second stage and shallow-water environments. Shallow water is indicated by abundant cross-bedding, ripple marks, and mud cracks in the units of clastic strata in the Crystal Spring, by algal stromatolites in the carbonate members of the Crystal Spring, and by algal stromatolites and layers of oolite in the Beck Spring. A progressive slowing of subsidence, with respect to sea level, and a concurrent lowering of the Nopah upland are indicated by the overall upward fining displayed by the clastic units, and by the deposition, in the later part of the first stage, of carbonate units across the trough site and onto the Nopah upland, which had been eroded to a platform. The emplacement of bodies of basic igneous rock, represented by the sill-forming diabase of the Crystal Spring Formation and diabase dikes in the crystalline complex, was confined almost entirely to the first stage, although basalt flows have been observed locally in the Kingston Peak Formation (A. L. Albee, personal communs.), as have thin layers of pale, fine-grained material that may be altered volcanic ash.

The second stage, which is recorded in the Kingston Peak Formation, the Noonday Dolomite, and the Noonday-equivalent basinal strata, on the other hand, was marked by higher marginal relief than the first stage showed, and by rapid subsidence of the trough, its central part receiving deeper water sediment throughout the stage.

The Kingston Peak and Noonday-equivalent strata of the central trough consistently show evidence of deposition below wave base. Most display graded bedding, some are thinly and continuously laminated, others are massive and essentially structureless, and all are devoid of the shallow-water features that characterize the sedimentary rocks of the first stage. The conglomeratic bodies of the Kingston Peak Formation that lie along the trough margins have long been believed to represent alluvial fans (Hewett, 1956; Kupfer, 1960).

In contrast to the modest marginal uplift and basin sinking of the first stage, which diminished with time, the basinal sinking and marginal relief related to the first half of the second stage apparently increased, as evidenced in a general upward coarsening of the Kingston Peak clastic sediments and an increase in the proportion of graded beds of sand. Conglomerate layers high in that formation contain clasts as much as 0.3 km long. Boulders associated with the deep-water turbidite and diamictite layers of the Kingston Peak, some of which are striated, are believed by some to constitute evidence of glacial rafting, but their presence in deep-water sediments might also be explained by transportation in dense submarine debris flows.

In the later part of the second stage, the Nopah upland was again reduced to a surface of low relief, but it was featured along its southern margin by ridges, as much as 300 m high, of resistant conglomerate of the Kingston Peak Formation. On this platform was deposited the algal carbonate of the Noonday Dolomite, while the trough was receiving the deep-water basinal arkosic deposits derived from the Mojave upland. Still later, the basin was filled and the platform was largely covered by the dolomite-quartz sandstone and breccia transported south ward.

That the Amargosa aulacogen is open and joins on the west to a Beltian geosyncline that was simultaneously receivi sediments like those of the aulacogen is suggested by the dist bution of the most westerly and northerly exposures of units correlative with the Pahrump Group. These units occur in a t that lies at a high angle to the aulacogen axis and extends alo the west side of the Panamint Range as far north as Tucki Mountain and thence to the northern part of the Funeral Mountains on the northeast side of Death Valley (Fig. 3B). They remain to be examined in detail, but are known to com prise a lower part composed of siliceous clastic and carbonate rocks intruded by basic sills and an upper part composed of conglomerate with carbonate clasts. Farther to the west and north only younger rocks are exposed.

In summary, the various structural, stratigraphic, and igneous features that compose the Pahrump-Noonday terrane and its two-stage evolution correspond in general to the distir guishing features attributed by Hoffman and others (1974) tc typical aulacogen. The trough that received the basinal Pahru and basinal Noonday-equivalent units was long-lived, being evidenced in stratigraphic units that cover the approximate time span of 1.4 to 0.7 b.y. If we have correctly interpreted t distribution of the most westerly and northerly of the Pahrun exposures, the trough joins with a Beltian geosyncline and lies at a high angle to the geosynclinal margin. The structural evol tion of the trough and the nature of the sediments it received was controlled primarily by vertical movements on faults bounding the blocks on the trough margin, moderate in the earlier stage and strong during most of the later stage of troug development. Igneous activity, represented entirely by basic rock, occurred mostly in the earlier stage when dikes and sills of diabase were emplaced.

Aulacogen-Miogeosyncline Transition

The problem of identifying the record of transition fron an aulacogenic to a miogeosynclinal environment in the Precai brian strata east of the Death Valley region remains unresolvec awaiting the acquisition of further data pertinent to the depos tional environments of the Johnnie, Stirling, and Wood Canyo When the quartzite member in the middle of the Johnnie (Fig. was deposited, the platform-trough boundaries of the propose aulacogen were apparently unexpressed topographically as the unit can be traced through the site of the trough and the immediately bordering uplands with no obvious variations except a thinning southward or southwestward. But the south to sout west paleoslope that is strongly suggested by paleocurrent dire tional features throughout the Johnnie is oriented similarly to the paleoslope upon which the earliest of the Pahrump strata were deposited. Measurements of limited numbers of direction features in the Stirling Quartzite suggest continuation of the south to southwest paleoslope for that formation in the Death Valley region, although the source or sources of the detrital quartz probably lay well beyond the sites of the aulacogen margins.

As Diehl (this volume) suggests, the principal indication of the change in provenance may well be the change to a north westerly orientation in paleoslope evidenced in the cross-beddi and carbonate units thickening through most of the Wood Canyon Formation in the sections that he has studied (Fig. 5, A and B). As only the arkose and arkosic conglomerate beds low in the middle member of the Wood Canyon display cross-bedding that is consistently oriented southwestward, these possibly constitute the final record of uplift related to the pre-miogeosynclinal provenance.

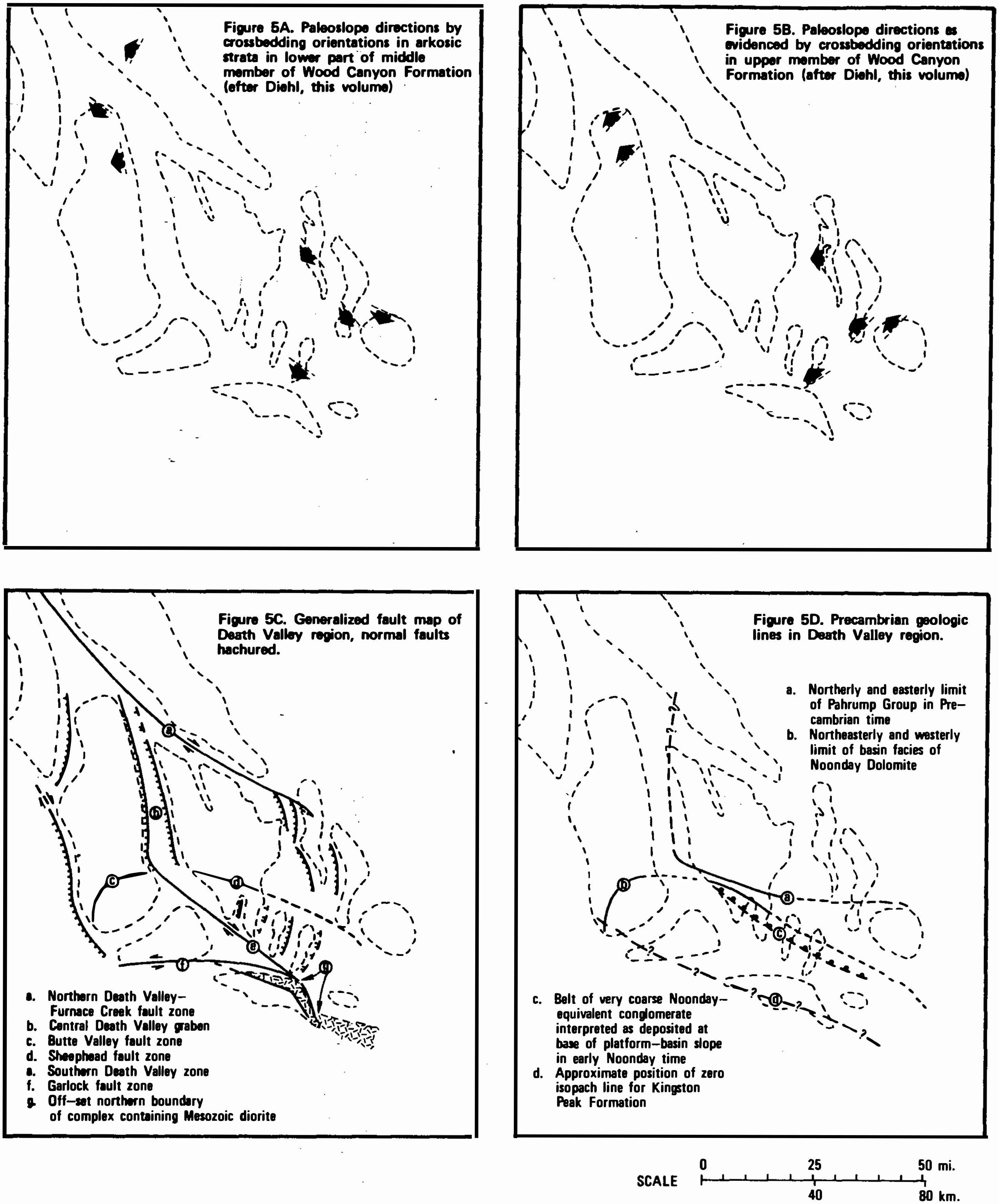


Figure 5. Paleoslope directions of Wood Canyon Formation, fault map, and Precambrian geologic lines, Death Valley region. See Figure 3a for identification of mountains.

REFERENCES CITED

Hazzard, J. C., 1937, Paleozoic section in the Nopah and Resting Springs Mountain, Inyo County, California: California Div. Mines, Jour. Mines and Geology, v. 33, no. 4, p. 273-339.

Hewett, D. F., 1956, Geology and mineral resources of the Ivanpah quadrangle, California and Nevada: U.S. Geol. Survey Prof. Paper 275, 172 p.

Hoffman, P., Dewey, J. F., and Burke, K., 1974, Aulacogens and their genetic relation to geosynclines with a Proterozoic example from the Great Slave Lake, Canada, *in* Dott, R. H., Jr., and Shaver, R. H., eds., Modern and ancient geosynclinal sedimentation: Soc. Econ. Paleontologists and Mineralogists Spec. Pub. 19 (in press).

Kupfer, D. H., 1960, Thrust faulting and chaos structure, Silurian Hills, San Bernardino County, California: Geol. Soc. America Bull., v. 71, no. 1, p. 181-214.

Noble, L. F., 1934, Rock formations of Death Valley, California: Science, v. 80, no. 2069, p. 173-178.

——— 1941, Structural features of the Virgin Spring area, Death Valley, California: Geol. Soc. America Bull., v. 52, p. 941-1000.

Stewart, J. H., 1972, Initial deposits in the Cordilleran geosyncline: Evidence of a late Precambrian (<850 m.y.) continental separation: Geol. Soc. America Bull., v. 83, p. 1345-1360.

Troxel, Bennie W., 1967, Sedimentary rocks of late Precambrian and Cambrian age in the southern Salt Spring Hills, southeastern Death Valley, California: California Div. Mines and Geology S Rept. 92, p. 33-41.

Wright, L. A., 1968, Talc deposits of the southern Death Valley-Kin Range region, California: California Div. Mines and Geology Spec. Rept. 95, 79 p.

——— 1973, Geology of the SE¼ of Tecopa 15-minute quadrangle, San Bernardino and Inyo Counties, California: California Div. Mines and Geology, Map Sheet 20.

Wright, Lauren A., and Troxel, Bennie W., 1966, Strata of late Precambrian-Cambrian age, Death Valley region, California-Nevada: Am. Assoc. Petroleum Geologists Bull., v. 50, no. 5, p. 846-857.

——— 1967, Limitations on right lateral strike-slip displacement, Death Valley and Furnace Creek fault zones, California: Geol. Soc. America Bull., v. 78, no. 8, p. 933-949.

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Stratigraphic Cross Section of Proterozoic Noonday Dolomite, War Eagle Mine Area, Southern Nopah Range, Eastern California

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