SHOULD THE TERM "GILA CONGLOMERATE" BE ABONDONED?

By

L. A. Heindl

ABSTRACT

Within each of the four areas in which it was originally described, the Gila Conglomerate can be separated into at least two, and in some places five, units. Furthermore, the four areas are in separate structural basins or troughs.

The units may be divided into two sets of deposits. The upper set includes the most widespread alluvial deposits in these basins. These deposits have a number of features in common which represent a depositional phase of the more or less contemporaneous development of large, distinct structural troughs. These similar features are (1) deposition within the boundaries of the present structural troughs, (2) derivation from adjacent or nearby mountains, (3) lack of mineralization, and (4) relationships to the late Pleistocene and Recent erosional cycles.

The lower set includes alluvial units (1) which are separated from the upper set by angular or erosional unconformities, (2) whose composition reflected source areas other than those presently exposed, and (3) which may have been deposited in basins other than those in existence today.

Because the term "Gila Conglomerate" refers to so many diverse units, it should be abandoned and the alluvial deposits in each individual basin should be given formational status according to the prevailing practices of designating stratigraphic units. The term "group" recently has been redefined to allow the inclusion of parallel units. Although this use of "group" to include horizontally equable units as well as those in vertical successions may lead to some confusion in correlation, a group designation would indicate the general similarity and contemporaneity of most of the deposits previously referred to the Gila Conglomerate. Therefore, "Gila" should be raised to group status to retain the familiar name to identify a large variety of deposits similar in type, time, and space. The Gila Group should be restricted to alluvial deposits of the upper set, excluding the deposits of the lower set, the overlying pediment and terrace gravels, and the younger alluvium.

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SHOULD THE TERM "GILA CONGLOMERATE" BE ABANDONED?1/

By

L. A. Heindl

The Cenozoic history of the area south and southeast of the Mogollon Rim in Arizona and New Mexico was dominated by a complex interrelationship of three geologic processes—volcanic activity, structural deformation, and nonmarine deposition—which took place within basins of interior or episodically integrated drainage. The area is a part of the Basin and Range province, which is generally described as a region of more or less separate mountain ranges standing high above wide, sloping alluvial plains. Briefly, the mountains are uplifted and tilted blocks and the basins are depressed areas partially filled by material derived from the adjacent mountains. These deposits, commonly called alluvial or valley fill, are composed of a wide variety of materials ranging in texture from conglomerate to claystone; in origin from clastic and pyroclastic to chemical and biogenic; and in environment from alluvial to paludal and lacustrine. Their sequence is broken by intervals of vulcanism, deformation, and erosion. Their distribution, succession, and relationship to structural movement are the key to the Cenozoic history of the area. Today, this history can be discussed in only general terms because the valley fills within the basins in this area, with minor exceptions noted below, are considered a single formation—the Gila Conglomerate. Not only are all the deposits within a single basin considered the Gila Conglomerate, but all the deposits in all the basins are so considered and are so identified, discussed, mapped, and correlated.

The term "Gila Conglomerate" was first applied in 1875 by Gilbert to alluvial deposits in four structural basins along the upper Gila River (figs. 6.1 and 6.2). Since then the term has been extended to other alluvial deposits on the basis of three criteria—textural similarity, lithologic similarity, and, in some places, apparent physical continuity. At the present time, the alluvial deposits in at least six major structural and topographic alinements in an area of more than 30,000 square miles are assigned to the Gila Conglomerate (fig. 6.1). Over a broader area, similar deposits have been correlated by being labeled Gila(?).

Alluvial deposits generally not included in the Gila Conglomerate are (1) younger deposits that are clearly in a state of aggradation or transit, such as surface gravels and flood-plain, terrace, and channel deposits of streams that have been incised into the mass of the basin fill; (2) somewhat less recent deposits that are clearly younger than the highest erosional surface cut on the basin fill; and (3) certain alluvial deposits older than the basin fill that have been separated because they are clearly related to volcanic rocks older than the basin fill or are in marked angular unconformity with the basin fill. The deposits of (1) and (2) are the only ones that have been consistently separated from the Gila.

1/ Publication approved by the Director, U.S. Geological Survey.

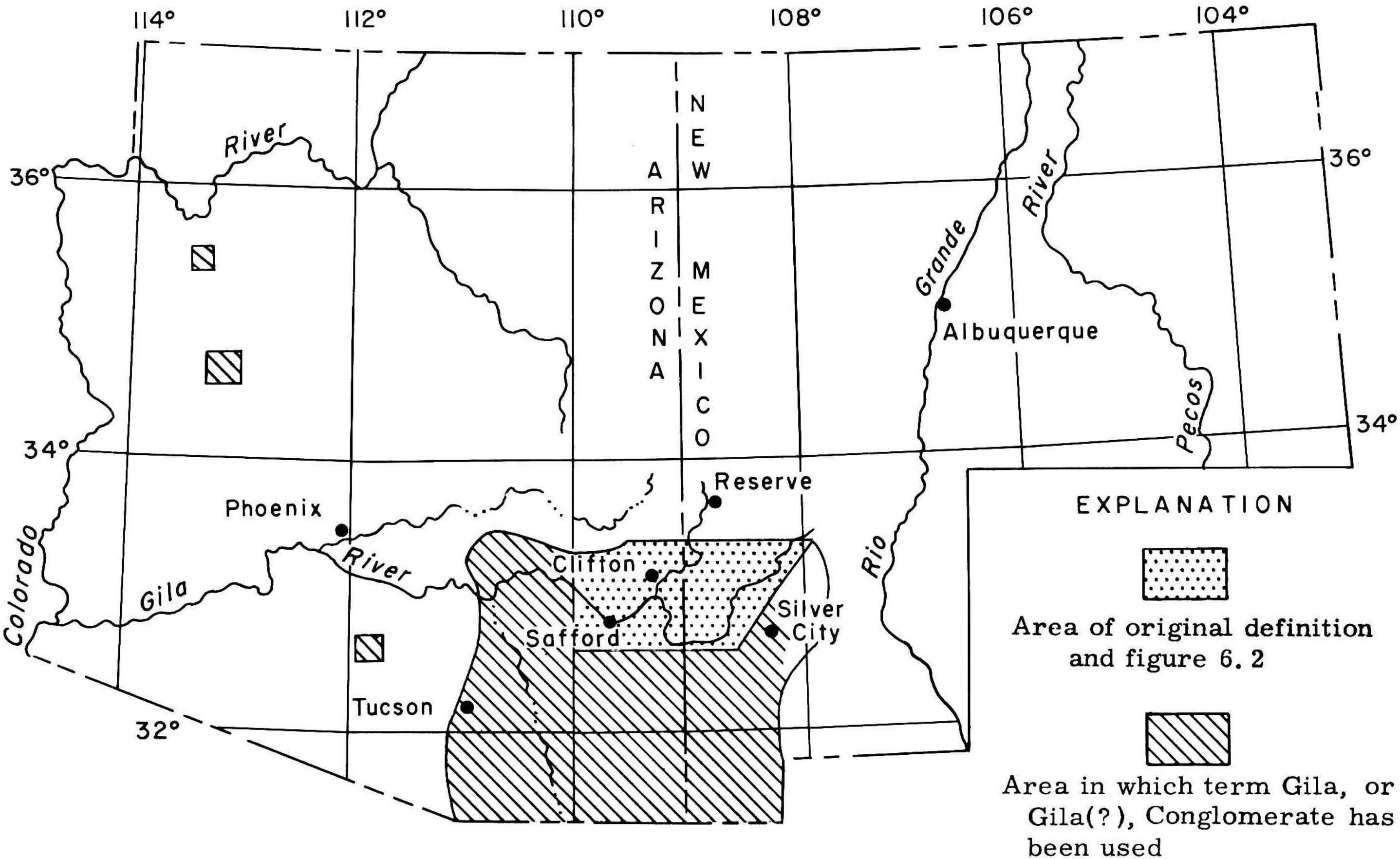


Figure 6.1.--Map of Arizona and New Mexico showing areas included in Gilbert's (1875) definition of the Gila Conglomerate and other areas to which the term has been extended.

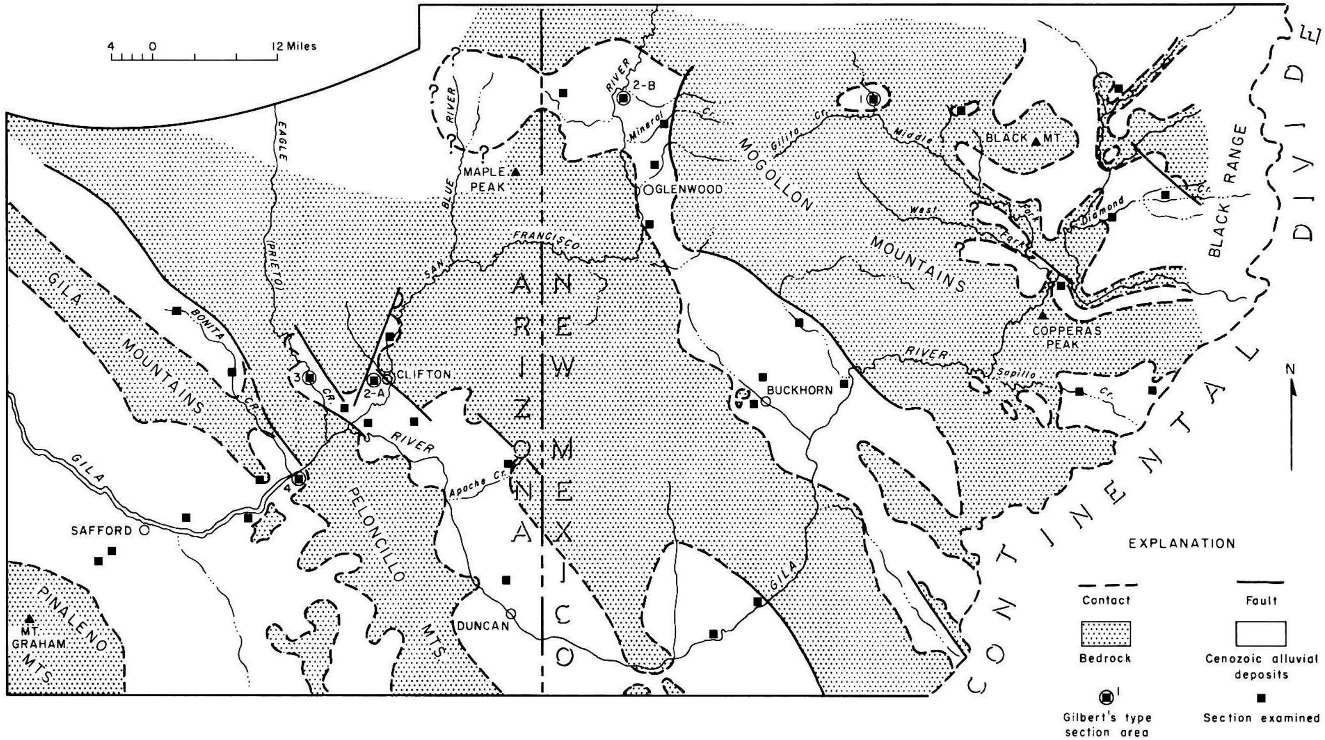


Figure 6. 2. --Map showing areas where Gilbert (1875) defined the Gila Conglomerate, generalized outlines of Cenozoic alluvial deposits, and sections examined.

The application of a single formational name to all but the most obviously unrelated alluvial deposits in the basins of the upper Gila River drainage area implies that (1) the formation is a unit or a group of related members that can be considered a single unit in the several basins; (2) the deposits in the several basins are correlatable; (3) the deposits in a single basin form a single unit; and (4) the term is adequate to express the character of these alluvial deposits.

In the last few years, geologic evidence of complex sedimentary and structural histories within individual basins, paleontologic evidence within the deposits of a range in ages and climates, and the growing economic importance of these deposits as a major source of ground water make it necessary to critically re-examine the existing approach to their study. It is proposed to apply the criteria for formational unity to those areas in which the Gila Conglomerate was first defined and to analyze the extent to which a single formation satisfies the conditions in those areas.

DESCRIPTION OF DEPOSITS

Gilbert (1875) cited four localities as containing Gila Conglomerate, and these may be considered the type localities (fig. 6.2). These, going downstream, are (1) above the mouth of Gilita Creek, (2) along the San Francisco River, (3) along Eagle (Prieto) Creek, and (4) in the vicinity of the mouth of Bonita (Bonito) Creek. Gilbert described the deposits of all four localities together, as follows:

> The boulders of the conglomerate are of local origin, and their derivation from particular mountain flanks is often indicated by the slopes of the beds. Its cement is calcareous. Interbedded with it are layers of slightly coherent sand and of trass, and sheets of basalt; the latter, in some cliffs, predominating over the conglomerate. One thousand feet of the beds are frequently exposed, and the maximum exposure on the Prieto is probably 1,500 feet. They have been seen at so many points by Mr. Howell and myself that their distribution can be given in general terms. Beginning at the mouth of the Bonito, below which point their distinctive characters are lost, they follow the Gila for more than 100 miles toward its source, being last seen a little above the mouth of the Gilita. On the San Francisco they extend 80 miles; on the Prieto, 10; and on the Bonito, 15. Where the Gila intersects the troughs of the Basin-Range system, as it does north of Ralston, the conglomerate is continuous with the gravels which occupy the troughs and floor of the desert plains. Below the Bonito it merges insensibly with the detritus of Pueblo Viejo Desert. It is, indeed, one of the 'Quaternary gravels' of the desert interior, and is distinguished from its family only by the fact that the water-courses which cross it are sinking themselves into it and destroying it instead of adding to its depth.

The sediments above the mouth of Gilita Creek are a part of the alluvial deposits forming a discontinuous pattern between the Continental Divide and the Mogollon Mountains, N. Mex. The deposits along the San Francisco River are restricted to those that lie in the structural trough between the Mogollon Mountains and the range to the west that includes Maple Peak. The strata along Eagle Creek are a portion of the deposits that partially fill the depression running south past Clifton to beyond Duncan, Ariz. The beds near the mouth of Bonita Creek are a part of the deposits that lie in the Safford-San Simon trough, Gilbert's Pueblo Viejo Desert.

The original localities were all examined in the field. In addition, exposures at other points within the basins were examined so as to obtain an overall picture of the deposits (fig. 6.2). Individual units described in this report, forming part of the deposits considered the Gila Conglomerate by Gilbert and others, are shown diagrammatically in figure 6.3.

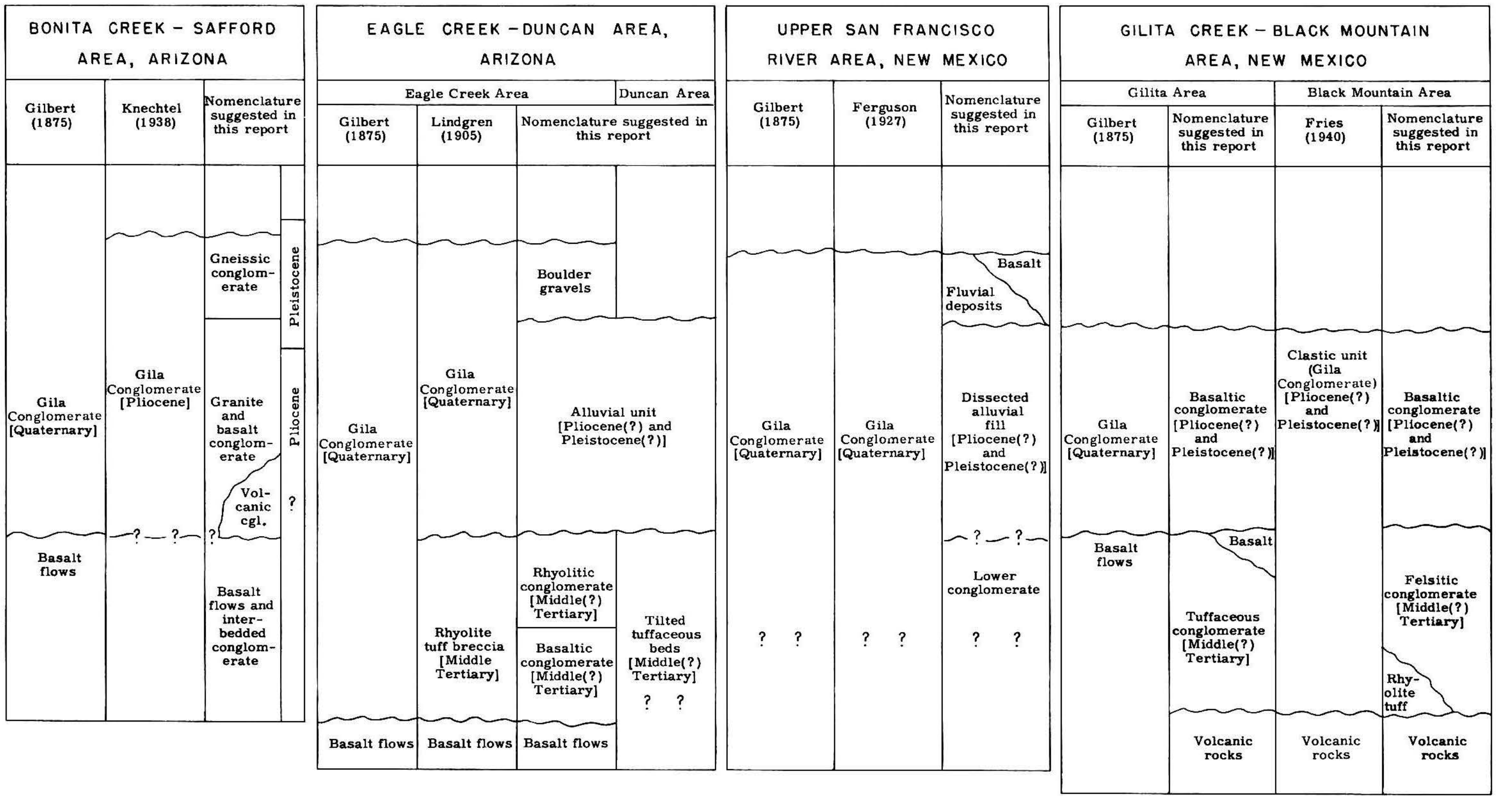
Gilita Creek-Black Mountain Area, New Mexico

Gilbert's easternmost-cited location of the Gila Conglomerate, above the mouth of Gilita Creek, contains two units, but only the lower unit is well exposed. The lower unit, herein referred to as the tuffaceous conglomerate, consists of about 300 feet of moderately well-consolidated tuffaceous conglomerate and sandstone whose coarse fragments are all composed of white rhyolite tuff with a scattering of reddish rhyolite fragments. A few thin lenses consist of basalt flows or of cobbles and pebbles of scoria. The base of the tuffaceous conglomerate is covered, but spatial relationships suggest that the unit was deposited on an erosion surface cut on a thick sequence of basalt flows. The tuffaceous conglomerate is overlain by younger basalt flows and a basaltic conglomerate unit. The basalt flows were laid down on a moderately irregular surface, but the contact between the tuffaceous and basaltic conglomerates was not seen. The basaltic conglomerate unit is almost completely masked by thin soil and gravels derived from its own float. These gravels, and a few poor exposures, indicate that the unit is composed of weakly consolidated beds containing basaltic and sialic volcanic fragments in about equal proportions. The relationship of the basaltic conglomerate and the basalt flows lying on top of the tuffaceous conglomerate is not known, but the topography suggests that the basaltic conglomerate may overlie the basalt flows.

The exposures on Gilita Creek form only the northwesternmost part of the valley-filling clastic deposits which, in a general way, almost completely girdle Black Mountain. East of Black Mountain, along the west front of the Black Range, these beds were considered by Fries (1940) "to correspond to what is known as the Gila conglomerate." Fries describes these as consisting of three parts, which he did not name but which are here designated as the rhyolite tuff, the felsitic conglomerate, and the basaltic conglomerate.

The rhyolite tuff is well exposed along the upper reaches of the Gila River and Beaver Creek, a north-trending tributary. Where present, it lies on a weakly eroded surface of underlying basalt flows, and the maximum observed thickness is about 100 feet. It is composed of bedded rhyolite tuff with intercalated lenses of sandy and conglomeratic fluvial deposits. The unit weathers to a conspicuous light-brown cliff splotched with yellow-green lichen. It is conformably overlain by the felsitic conglomerate.

The felsitic conglomerate is most conspicuously exposed at the junction of the West Fork and Gila Rivers, where it forms rugged, steeply rounded or sheer cliffs up to 500 feet high. The rhyolite tuff is absent in this area and the basal bed of the felsitic conglomerate is a lenticular conglomerate up to 15 feet thick, composed of fragments derived from underlying andesitic and basaltic flows. The felsitic conglomerate is composed predominantly of moderately



Note: An unbroken straight line indicates a conformable contact between units.
A wavy line indicates the presence of an erosional surface between or above units.
A query indicates a questionable contact or relationship, or an unknown base.

These charts do not show thickness, extent, or correlation of units between areas.

Figure 6. 3—Charts showing Cenozoic alluvial deposits in areas of Gilbert's (1875) original definition of the Gila Conglomerate, upper Gila River basin, Arizona and New Mexico. (Pleistocene and Recent alluvial deposits not included)

well consolidated light-gray felsitic fragments with subordinate amounts of andesitic and basaltic fragments. The andesitic material diminishes northward as rhyolitic tuff fragments increase until, locally, the felsitic conglomerate is similar in appearance to the tuffaceous conglomerate near Gilita Creek. The felsitic conglomerate is conformably overlain by and in part gradational into the basaltic conglomerate.

The basaltic conglomerate is distinguished from the felsitic conglomerate by composition and texture. In the basaltic conglomerate there is an abrupt increase in the proportion of mafic volcanic material, and a corresponding decrease in the sialic types. The beds are poorly consolidated and are characterized by irregular lensing and scour-and-fill structure. The unit has a maximum thickness of about 700 feet. The basaltic conglomerate is cut by the highest erosion surfaces and is overlain by a few feet of unconsolidated gravel. The basaltic conglomerates in the Gilita Creek and Black Mountain areas are similar.

The tuffaceous conglomerate near Gilita Creek is similar to portions of the felsitic conglomerate. However, there are several points of dissimilarity or questionable similarity which make it difficult to accept the two as a single unit on the basis of lithologic and textural similarity alone. The tuffaceous conglomerate is overlain by basalt flows and deposits similar to the tuffaceous conglomerate; in the general vicinity of Gilita Creek, up to 80 feet of the tuffaceous conglomerate was observed to be intercalated between basalt flows. At no point was the felsitic conglomerate, some 10 miles southeast of the Gilita Creek exposures, seen in similar relationship. The two areas are separated by about a 10-mile band of volcanic rocks made up mainly of rhyolite and basalt flows. Along the Middle Fork River, which cuts between the two areas, no deposits were noted to suggest that the tuffaceous conglomerate interfingers with, or is transitional or gradational into, the felsitic conglomerate. However, the lithologic and textural similarity is striking and the possibility of deposition into two separate areas from a single source cannot be eliminated.

In contrast to the tuffaceous and felsitic conglomerates, the basaltic conglomerates reflect the composition of the rocks in the present topographic highs. The felsitic conglomerate has been faulted through its full thickness along the southern border against the volcanic rodge that includes Copperas Peak. Only the lower portion of the basaltic conglomerate in the Black Mountain area is known to be cut by faults (Fries, 1940). The differences in the composition of the felsitic conglomerate and basaltic conglomerate must be considered also in their relationship to the adjacent basaltic mass of Black Mountain. Compared with the basaltic conglomerate, the felsitic conglomerate contains only a comparatively small percentage of rocks of the type making up Black Mountain. This suggests that the two units have a dissimilar history in relationship to Black Mountain. Parenthetically, the felsitic conglomerate is compositionally and texturally similar to deposits along Sapillo Creek south of the ridge including Copperas Peak. They may represent portions of a single unit that was breached by the horst including Copperas Peak.

Upper San Francisco River Area, New Mexico

The alluvial deposits at Gilbert's second locality of Gila Conglomerate, along the San Francisco River, lie in two valleys separated by a wide volcanic ridge culminating in Maple Peak. The San Francisco River cuts a deep east-west gorge through the volcanic ridge, and the resulting exposures show that the alluvial deposits of the two valleys are clearly separate (fig. 6.2), each dipping away from the volcanic ridge into its basin of deposition. The deposits to the west, along the lower portion of the San Francisco River, will be discussed with those along Eagle Creek; the deposits along the upper, or eastern, portion of the San Francisco River are considered here.

The deposits along the upper San Francisco River lie mostly in New Mexico between the Mogollon Mountains on the east and the volcanic ridge that includes Maple Peak on the west. Here they were correlated with the Gila Conglomerate by Ferguson (1927). They continue westward around the north end of the Maple Peak ridge into the drainage area of the Blue River, north of Clifton, Ariz. To the south they are continuous with deposits considered the Gila Conglomerate by Paige (1916). Deposits in this long trough of deposition were examined by the writer only in the area northwest of the Gila River. Except for one small exposure of possibly older alluvial material and some younger deposits, these form essentially one unit, herein referred to as the dissected alluvial fill.

Along the northeast margin of occurrence, the beds of the dissected alluvial fill are in fault contact with the rocks of the Mogollon Mountains. To the north the beds have been laid down on volcanic rocks, but faulting also may be present, as deposits similar to the dissected alluvial fill were observed at a higher altitude on the slopes of Brushy Mountain. The contact between the dissected alluvial fill and the underlying volcanic rocks around the north end of the Maple Peak ridge also is essentially depositional but is modified locally by faulting. Along the west margin, along the Maple Peak ridge and south to Buckhorn, the contact is depositional. The nature of the northwest contact in the vicinity of the Blue River is not known.

The dissected alluvial fill consists of conglomerate, sandstone, mudstone, claystone, and diatomite, laid down in fairly well defined zones or areas. Against the Mogollon Mountains, the beds are predominantly conglomerate, with interbedded sandstone and less numerous mudstone lenses. The material decreases in average grain size westward from the Mogollon Mountains through a zone ranging in width from about 2 to about 5 miles. Where the zone is wider, the material grades into lake or playa deposits; where the zone is narrower, the materials grade into sandstone and granule conglomerate. Along the Maple Peak ridge there is a second zone of cobble to boulder conglomerate that is markedly narrower, in many places less than 100 feet wide. This zone interfingers eastward with the sandstone and granule conglomerate of the deposits of the first zone or with lake and playa deposits. A third, poorly defined zone of conglomerate extends generally northward of the Maple Peak ridge and grades to both the east and the west into finer deposits. The finer grained deposits, predominantly mudstone and sandstone with thin interbedded pebbly beds and, locally, diatomite, are interpreted as playa, flood-plain, or lake deposits. These are located in three separate areas, one centering approximately on Buckhorn, one about 6 miles north of Glenwood, and one northwest of the north end of Maple Peak ridge.

The composition of the dissected alluvial fill everywhere reflects that of the materials in the adjacent mountains. Along the Mogollon Mountains, where a thickness of about 700 feet of this alluvial material is exposed, two phases of deposition are discernible. The lower part of the deposits is composed predominantly of sialic volcanic types in moderately well bedded and sorted lenses. This part grades upward through a thin, irregular zone into the upper phase, which contains higher percentages of intermediate and mafic volcanic rocks and is noticeably poorer in sorting, and less regular in bedding. Away from the Mogollon Mountain front, thin lenses of small pebble conglomerate and pebbly sandstone are composed predominantly of sialic volcanic types. These suggest that the fine-grained deposits in the areas around Buckhorn and north of Glenwood grade into the lower zone; however, the composition of the fine-grained beds may be the result of the greater susceptibility to weathering and disintegration of the intermediate and mafic volcanic rocks. No correlation is made at this time.

The base of the dissected alluvial fill, except along its margins, is not known. In the bottom of Mineral Creek near the bounding fault, a single exposure of a badly fractured conglomerate of considerably greater induration and differing texture and composition suggests the presence in this trough of alluvial deposits below the dissected alluvial fill.

At the north end of the Maple Peak ridge, and north of Glenwood, basaltic flows locally lie on an erosion surface cut on the fill. Elsewhere, the top of the fill is generally overlain by a few feet of loose gravel that is more or less parallel to the present erosion surface. Along the San Francisco River and some of its northeast tributaries, fluvial deposits, high above the present washes, lie in channels incised into the bulk of the valley fill but below the mesa surface and the capping gravels. The contact of these fluvial deposits with the valley fill may be sharp and steep, and exposed channels nearly 100 feet deep were observed; more commonly the contact is a transition zone in which the material of the dissected alluvial fill is a part of the basal portion of the younger deposits. The composition of these basal beds is similar to the incised deposits, but their texture is controlled by the younger stream regimen. These beds represent a phase of the degradational cycle which must be considered separately from the main mass of the dissected alluvial fill, even though both lie beneath the present broad erosion surfaces.

Eagle (Prieto) Creek-Duncan Area, Arizona

The third Gila Conglomerate locality cited by Gilbert is along Eagle, or Prieto, Creek. These alluvial deposits are in part coextensive with those extending up the lower San Francisco River and those that partially fill the valley east of the Peloncillo Mountains. For the most part they lie in Arizona, but beyond Duncan they extend southward into New Mexico. In this valley four units are designated. Three of these units are along Eagle Creek—basaltic conglomerate at the bottom, rhyolitic conglomerate in the middle, and an alluvial unit at the top. South of the confluences of Eagle Creek and the San Francisco River with the Gila River, the alluvial unit forms the bulk of the exposed alluvial deposits. A fourth unit consists of tuffaceous volcanic conglomerate, and sandstone is exposed below the alluvial unit locally along the east margin of the valley.

Along the center of the valley of Eagle Creek, the basaltic conglomerate is depositional on the underlying basalt flows. The basaltic conglomerate is composed of dark-red-brown crudely bedded, poorly sorted basalt-boulder conglomerate lenses, which were observed to be about 100 feet thick but may be thicker. This unit contains a few small pebbles of rhyolite. It is conformably overlain by the rhyolitic conglomerate.

The rhyolitic conglomerate is spectacularly exposed along the Eagle

Creek valley. The unit is composed of lenses of granule to cobble conglomerate, interbedded with tuffaceous sandstone and tuff. The rhyolite fragments are predominant but andesitic fragments are common, and in the lowest beds basaltic fragments are conspicuous. The rhyolitic conglomerate is essentially conformable to the underlying unit but locally is separated by a conformable erosion surface. The unit is about 1,000 feet thick. This unit was considered by Lindgren (1905) to be a tuff breccia, but the presence of lensing, crossbedding, cut-and-fill channeling, and rounded pebbles and a suggestion of ripple marks in some of the fine-grained beds attest to the alluvial origin originally ascribed to this unit by Gilbert. The rhyolitic conglomerate is clearly in fault contact with the older volcanic intrusive and sedimentary rocks on the east side of the valley, and possibly also with the volcanic rocks on the west side. This unit is overlain by the alluvial unit along its southeast exposures.

Tilted beds of conglomerate consisting of well-bedded tuffaceous volcanic conglomerate, sandstone, and tuff are exposed along Apache Creek, about 20 miles southeast of Clifton, and are herein called the tilted tuffaceous beds. These tilted tuffaceous beds contain a high percentage of reddish and orange altered volcanic rocks of possible andesitic composition. About 500 feet of these tuffaceous beds are exposed. The relationship of this unit to the basaltic and rhyolitic conglomerate units along Eagle Creek is not known, except that all three are clearly older than the alluvial unit. There is a noticeable resemblance between the tilted tuffaceous beds and the felsitic conglomerate in the Black Mountain area, but no correlation is implied by this observation.

The alluvial unit forms the major part of the valley-fill deposits in the basin and extends from south of Duncan north to Clifton and into the lower reaches of the San Francisco River and into the southeastern corner of the valley of Eagle Creek. The contact with the marginal rocks is generally depositional but is locally faulted, as near the mouth of the San Francisco River and in the vicinity of Clifton. The materials composing the alluvial unit can generally be readily related to the adjoining bedrock sources, with the exception of some materials which may have been carried considerable distances from upstream sources. In the Clifton area, beds of the alluvial unit along the mountain fronts are predominantly conglomerate, with lesser proportions of sandstone and mudstone lenses. These grade to finer grained beds along the central portion between the mountains, which in turn grade into lake and playa deposits near Duncan. On the northeast side of the valley, the predominantly conglomeratic rocks grade laterally over a zone several miles wide into the predominantly sandstone and mudstone sequence. Along the Peloncillo Mountains the conglomerate zone is narrow, and the coarse conglomerate lenses of rocks typical of the Peloncillo Mountains interfinger with small pebble conglomerate, sandstone, and mudstone derived from rocks similar in composition to those of Big Lue Mountain and the Mogollon Rim. To the south, in the vicinity of Duncan, the alluvial unit grades laterally into the playa or lake beds containing diatomaceous material and some marly beds.

In the southeast corner of the Eagle Creek valley the alluvial unit rests on an erosion surface cut on the rhyolitic conglomerate, and their angular relationship ranges from parallel to slightly disconformable. Near the mouth of the San Francisco River a similar relationship is believed to exist, but the beds here are only tentatively assigned to the rhyolitic conglomerate. Along Apache Creek, beds considered to represent the alluvial unit rest with a prominent angular unconformity on tilted tuffaceous beds. The top of the alluvial unit is everywhere an erosion surface underlain by a thin, irregular layer of loose or poorly consolidated gravel.

Near the mouth of the San Francisco River the alluvial unit may be separated into two distinct facies. The lower of these is a basaltic conglomerate containing only a few rhyolite fragments, which rests with a slight disconformity on rhyolite-heavy beds tentatively assigned to the rhyolitic conglomerate. The basaltic conglomerate of the alluvial unit is as much as 250 feet thick and grades upward into the beds typical of the alluvial unit which are characterized by a gray color, fragments of red granite and rhyolite, and moderately well developed bedding. The contact between the rhyolitic conglomerate and the alluvial unit is locally marked by a basalt flow, and basalt flows are present locally in the lower part of the alluvial unit. The alluvial unit is probably about 1,000 feet thick, and the top 300 feet is characterized by a larger percentage of silt, coarse, less regular bedding, and poorer sorting. The excellent exposures in the road cuts along the highway south of Clifton are of the upper 700 feet of the alluvial unit.

Bonita Creek-Safford Area, Arizona

The fourth and last of Gilbert's original locations of the Gila Conglomerate is at the mouth, and in the vicinity, of Bonita Creek. At the mouth of Bonita Creek, conglomerate crops out in a thickness of about 1,000 feet. The conglomerate rests on an irregular surface cut on basalt flows which are interbedded with conglomerate lenses, and it is capped by a few feet of gravel below the present surface. Along the Gila River this capping is composed of terrace gravel deposited by the Gila River; the gravel on the higher surfaces was derived from weathering of the underlying conglomerate.

Van Horn (1957) stated that the conglomerate at the mouth of Bonita Creek is separable into two units. The lower unit, here called the volcanic conglomerate, forms the basal cliffs and is characterized by basaltic and rhyolitic rocks and the absence of granitic or quartzitic rocks. The upper unit, also a conglomerate, contains the same suite of volcanic rocks and in addition is distinguished by conspicuous, if not plentiful, fragments of red granite, cross-bedded Cambrian(?) quartzite, and a scattering of other sedimentary rocks. Van Horn (1957) stated that the upper conglomerate grades into and interfingers with lake beds exposed along the Safford Valley to the west. The upper unit is here referred to as the granite and basalt conglomerate. Near the mouth of Bonita Creek, the contact between the two units is a transition zone. At the south end of the Gila Mountains, however, the granite and basalt conglomerate fills a 200-foot-deep valley cut into the lower conglomerate along its contact with older volcanic rocks. The presence of at least 200 feet of relief on the erosion surface between the two units, differences in composition, and the possible existence of a bedrock barrier composed of a southern extension of the Gila Mountains lend weight to the separation of the two units. The volcanic conglomerate underlies exposed lake beds near the level of the Gila River at the south end of the Gila Mountains, and its relationship to the nearly 1,200 feet of fine-grained material below the surface of Safford Valley is not known.

The granite and basalt conglomerate is essentially horizontal and is continuous across the Safford Valley to the Graham Mountains where, at Frye Mesa, it is composed of cobble conglomerate having a greenish muddy matrix. In this area it passes under, and grades upward into, a series of massive gneissic boulder alluvial fans derived from the adjoining mountains. At its most conspicuous exposure the gneissic conglomerate is about 700 feet thick. In the central part of the valley, the fine-grained deposits and lake beds are nearly everywhere capped by a few feet of stream or sheetwash gravel, which has been dissected to expose the underlying sand, silt, and clay. The relationship of the gneissic conglomerate to this gravel is not known.

AGE OF DEPOSITS

Gilbert (1875) considered the Gila Conglomerate to be of Quaternary age. Except in the Bonita Creek-Safford area, the age of the units described is unknown. Fossil evidence from the granite and basalt conglomerate in the Bonita-Safford area shows that it ranges from late Pliocene (Knechtel, 1938) to Pleistocene, probably Kansan (Van Horn, this volume). The volcanic conglomerate is, then, no younger than late Pliocene. Cope (1884) suggested a Miocene age for one reported vertebrate fossil from the dissected alluvial fill along the upper San Francisco River, but it is possible that the material then considered Miocene may be what is now considered Pliocene (J. F. Lance, personal communication, 1954). Fossil evidence from the other units has not been reported, but on the basis of relationships to the existing topography and the present erosion cycle, a general Pliocene to early Pleistocene age is considered probable for the basaltic conglomerate in the Gilita-Black Mountain area, the dissected alluvial fill in the upper San Francisco River area, and the alluvial unit in the Eagle Creek-Duncan area.

The older alluvial units described are tentatively considered to be of about middle Tertiary age.

SUMMARY OF DESCRIPTIONS

A summary of the descriptions and of some conclusions that can be drawn from this analysis is itemized as follows:

1. The deposits are in separate topographic basins which have developed in separate, though perhaps related, structural depressions. No direct continuity of the deposits across or through the mountain ranges can be demonstrated at this time. The possibility that there may be some physical continuity between the dissected alluvial fill in the upper San Francisco area and the upper alluvial unit in the Eagle Creek-Duncan area under the broad basins south of Silver City is not eliminated, but it cannot be assumed merely on the basis of the continuity of surface gravels.

2. The deposits in the four basins can be separated as follows:

   A. Gilita Creek-Black Mountain area: The tuffaceous conglomerate is that "last seen a little above the mouth of the Gilita" by Gilbert (1875). Its composition does not reflect derivation from the adjacent mountain flanks, nor does that of the felsitic conglomerate. The felsitic conglomerate is partly similar in composition and texture to the tuffaceous conglomerate and to the deposits along Sapillo Creek. In contrast, the two upper basaltic conglomerates are both derived from the adjacent mountains.

B. Upper San Francisco River area: The major part of the basin fill forms a single unit, the dissected alluvial fill, which is derived from the nearby mountains.

C. Eagle Creek-Duncan area: The deposits mentioned by Gilbert in Eagle (Prieto) Creek belong to the basaltic and rhyolitic conglomerate units. The rhyolitic conglomerate does not reflect the composition of the adjacent mountains, whereas the overlying alluvial unit does. Along the east flank of the basin, the tilted tuffaceous beds are lithologically different from the alluvial unit and underlie it with a distinct angular unconformity. The relation of the basaltic and rhyolitic conglomerates to the tilted tuffaceous beds is not known.

D. Bonita Creek-Safford area: The alluvial deposits at the mouth of Bonita Creek are separated by compositional differences and an erosional surface into the lower conglomerate below and the granite and basalt conglomerate above. Only the granite and basalt conglomerate can be traced into the finer grained deposits and lake beds exposed in the central part of the Safford Valley. The gneissic conglomerate, on the west side of the Safford Valley, is younger than the granite and basalt conglomerate.

3. The above-listed units can be divided into two sets of alluvial deposits. The uppermost set includes the basaltic conglomerate in the Gilita Creek-Black Mountain area, the dissected alluvial fill in the upper San Francisco River area, the alluvial unit in the Eagle Creek-Duncan area, and the gneissic conglomerate, granite and basalt conglomerate, and volcanic conglomerate in the Bonita Creek-Safford area. The lowermost set includes the tuffaceous and felsitic conglomerates in the Gilita Creek-Black Mountain area and the basaltic and rhyolitic conglomerates and tilted tuffaceous beds in the Eagle Creek-Duncan area.

(Ed. note: A more detailed classification than that given here, both on areas of alluvial deposits in the upper Gila River basin as well as Gilbert's original areas, is summarized by Wood, 1959.)

4. The units of the uppermost set in each basin reflect deposition from rocks in the adjacent mountains, and the partial filling of the depressed areas created by the most recent major structural deformation. The uppermost units are either in depositional or normal-fault contact with the existing bedrock; the fault relationship does not affect the direct relationship between the materials in the deposits and the adjoining source areas. The uppermost units represent a more or less single aggradational sequence.

5. The units of the lowermost set are in part derived from rocks in the adjacent mountain areas, but, distinctively, they also contain rock types whose entry into the basin requires structural explanation and they lack rock types that should logically have been derived from the existing highlands. The structural relationship between the units of the lowermost set and the existing topography suggests that these units cannot be assumed to have been deposited in the same basins as the units of the uppermost set. In some places the deposition may be

a distinctive local feature; in other places the deposition suggests basins that cross the present structural and topographic boundaries. Units of the lowermost set are not exposed and are not known to be present in the upper San Francisco River and Bonita Creek-Safford areas.

6. The contact between the units of the uppermost and lowermost sets may be a disconformity or an angular unconformity, and the two types of unconformities may merge into each other along strike or dip.

7. The upper contacts of the upper units are generally broad erosion surfaces marked by an irregular, thin sequence of poorly consolidated gravels. Locally the erosion surfaces may be underlain by gravel deposits younger than the units of the uppermost set and older than the loose gravel mantle. These gravel deposits represent a sequence of erosion and deposition separate from the depositional sequence represented by the units of the uppermost set.

8. The granite and basalt conglomerate of the uppermost set in the Bonita Creek-Safford area is the only one for a part of which a definite age can be given. Exposed parts of the granite and basalt conglomerate range in age from late Pliocene to early Pleistocene. The similarity of the rock types of the upper units and of their relationships to their surrounding topography suggests that they may all have been deposited during the same general period of time.

9. The ages of the units of the lowermost set are not known. Because they are less uniform in character than the units of the upper set, and more diverse in their structural relationship to the rocks in the mountain areas, their ages are considered more generally as pre-Pliocene, possibly middle Tertiary.

NOMENCLATURE

The foregoing description demonstrates that the deposits to which the term "Gila Conglomerate" was originally applied are not a single homogeneous unit, and that the different units of which they consist represent deposition in more than a single structural environment. The deposits in the four areas that are remarkably similar, those of the uppermost set, were deposited in separate basins. There is insufficient paleontologic evidence at this time to justify the correlation of deposits between areas. This applies equally to units in different parts of a single basin. Because of the variety of units included in the original description, no one unit can be singled out as <u>the</u> Gila Conglomerate. For the same reason it is obvious, in the author's <u>opinion</u>, that the term "Gila Conglomerate" is inadequate to describe any of the alluvial deposits in its type areas and therefore should be abandoned as a formational name. As these four areas are the foundation for the use of the term in other areas, the author believes that the term is inadequate and should be abandoned elsewhere also.

The above conclusion presents two questions of nomenclature. First, if the name Gila Conglomerate were to be abandoned, should the separate units be given formal names; and second, should the term Gila be retained in some sense to imply the similarity that exists between some of the deposits?

If these deposits are not to be considered as Gila Conglomerate, how should they be designated? The author suggests that, within each individual basin, the alluvial deposits be given formational status according to the prevailing practices of designating formational units. He believes that all units described in this paper could well be given formational or member status. The same formational name should not be applied to the deposits in more than one basin until evidence is presented to validate such continuity. Again, it should be pointed out that the continuity of the uppermost deposits across a mountain pass or around the end of a buried mountain range does not constitute evidence for the continuity of all the underlying strata. Rather, it should serve as the basis for a further subdivision of alluvial units, separating the deposits laid down in individual basins from those deposits that transgressed the structural depressions.

Within the suggested formations it would be constructive to designate units of similar lithology as members. As an example, the dissected alluvial fill in the upper San Francisco area could be divided into members both vertically and laterally. Laterally, it might be helpful to define separately seven units: the fine-grained deposits around Buckhorn, north of Glenwood, and northwest of the Maple Peak ridge; the narrow conglomerate zone along the east margin of the Maple Peak ridge; the wide conglomerate zone along the Mogollon Mountains; and the conglomerate zone between the fine-grained deposits north of Glenwood and those northwest of Maple Peak ridge. At least in one area, along the northern front of the Mogollon Mountains, the conglomerate member could be separated into a lower sialic member and an upper andesitic member.

Because of the rapidity with which alluvial units may change vertically and laterally, caution should be exercised in proposing formal names. It is suggested that such units be designated descriptively according to their lithology and texture until they can be shown to warrant formal naming.

At first glance, it might appear unfeasible to raise the Gila to group status because a group normally includes units that succeed each other rather than units which correlate with each other. However, the inclusion of parallel units of alluvial deposits under a common name has served a useful purpose in many instances, such as the Bridger, Esmerelda, and Truckee Formations, and the Santa Fe and Wasatch Groups. In addition, a preliminary draft of a revised definition of "group" by the American Commission on Stratigraphic Nomenclature states "Groups are established for the purpose of expressing and contrasting the natural relations of the various formations in an area, thereby aiding the description and interpretation of the geology of that area. . . . The succession of formations comprising a group need not necessarily be the same throughout the area in which the group is recognized" (G. V. Cohee, written communication, July 24, 1959). Under this redefinition of the term, horizontal groups may be established to include similar, more or less contemporaneous, deposits. Although the writer believes that the use of the term "group" to include deposits of horizontal equability as well as vertical succession will lead to some confusion, the redefinition of "group" provides a means by which general similarity and contemporaneity of deposits may be recognized. Therefore it is suggested that, as early as substantiating field mapping defines the formations in individual basins, the Gila be raised to group status to include the uppermost set and similar alluvial deposits and to exclude the lowermost set and the overlying Quaternary pediment and terrace gravels and younger alluvium. The Gila Group as so defined would include those deposits that appear to have been laid down during a certain more or less contemporaneous phase of the development of large structural troughs of the basin-and-range variety. The deposits of the Gila Group would be derived principally from rocks in adjoining or nearby mountains; laid down in the present general topographic and structural depressions; would show generally normal size-gradation relationships from margin to centers, commensurate with the intricacies of deposition in long and intricately bordered troughs; and would lack mineralization.

The general similarity and contemporaneity of these rocks in their general orientation in space and time will be shown by the retention of the familiar name Gila, raised to group status. The unravelling of the local complexity of these deposits will obviously result in a plethora of new names, but any attempt to describe the Cenozoic history of the region as a whole must depend on an understanding of the stratigraphic relationships of individual deposits. This understanding cannot be achieved until the deposits are correctly subdivided into their component parts.

(Ed. note: The Gila was raised to group status in the description of the Cenozoic alluvial deposits near Mammoth, about 30 miles northeast of Tucson (Heindl, 1963.)