# *Resume of the geology of the Gallinas Mountains, New Mexico*

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# RESUME OF THE GEOLOGY OF THE GALLINAS MOUNTAINS

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## INTRODUCTION

Central New Mexico is characterized by a number of intrusive masses which have uplifted and domed the overlying sedimentary rocks. The Gallinas Mountains in northern Lincoln County (fig. 1) are one of the largest of these igneous centers and affords an excellent opportunity for investigating the nature of the intrusives and attendant structural deformation. Also the uplifted and tilted sedimentary rocks allow study of the Permian stratigraphy in that area and its relation to regional sedimentation.

The range consists of a granite core overlain by nearly 2,000 feet of clastic sedimentary rocks into which were intruded a variety of alkalic and subsilic hypabyssal rocks. Doming and faulting accompanied the igneous activity. Because of the limited sedimentary section and absence of fossils, dating of geologic events in the Gallinas Mountains is difficult. However, lithologic correlation and stratigraphic position can be used to date the sediments. Similarly, the igneous activity and structural deformation can be dated by comparison with other areas.

## STRATIGRAPHY

### Precambrian Rocks

A light-gray granite underlies the sedimentary rocks. This granite, which is exposed by faulting, in only three places in the mountains is massive, equigranular, and medium- to fine-grained. Its mineralogy is simple; quartz, microcline, and sodic oligoclase ($Ab_{88}$) are the essential constituents.

The granite can only be dated as pre-Abo because the Abo Formation is the oldest unit lying upon it (table 1). In the absence, however, of any known Paleozoic intrusive activity in New Mexico and by analogy with nearby areas, the granite is probably Precambrian. Similar granite is exposed at a number of places near the Gallinas Mountains. In the Pedernal Hills, 50 miles north of the range, a Precambrian granite is exposed, and there are small granite hills near Duran, Cedarville, and Corona. Although alluvium obscures the granite-Permian contacts, all of these hills are probably inliers from a pre-Abo landmass which existed in this part of the state throughout much of the Paleozoic (Thompson, 1942, p. 13).

Table 1. — Permian stratigraphy of the Gallinas Mountains, New Mexico.

| Series | Formation | Approx. Thickness (feet) | Lithology |
|---|---|---|---|
| Upper Leonard | Glorieta | 250 | Quartzose sandstone |
| Lower Leonard | Yeso | 1,500 | Mostly fine-grained feldspathic sandstone with minor siltstone, shale, limestone, and dolomitic limestone |
| Wolfcamp | Abo | 150 | Arkosic conglomerate, plus ferruginous sandstone and siltstone |

### Paleozoic Rocks

#### Abo Formation

The Abo Formation is the oldest sedimentary unit exposed in the area. It lies unconformably on granite, and grades upward into the Yeso Formation. Because of this gradational contact, the thickness of the Abo is not easily measured. The Abo has a thickness of about 150 feet in this area if the disappearance of pebbles is used to mark the Abo-Yeso boundary.

The formation consists of a basal arkosic conglomerate member and an overlying member composed of red, feldspathic shale, sandstone and conglomerate. Although

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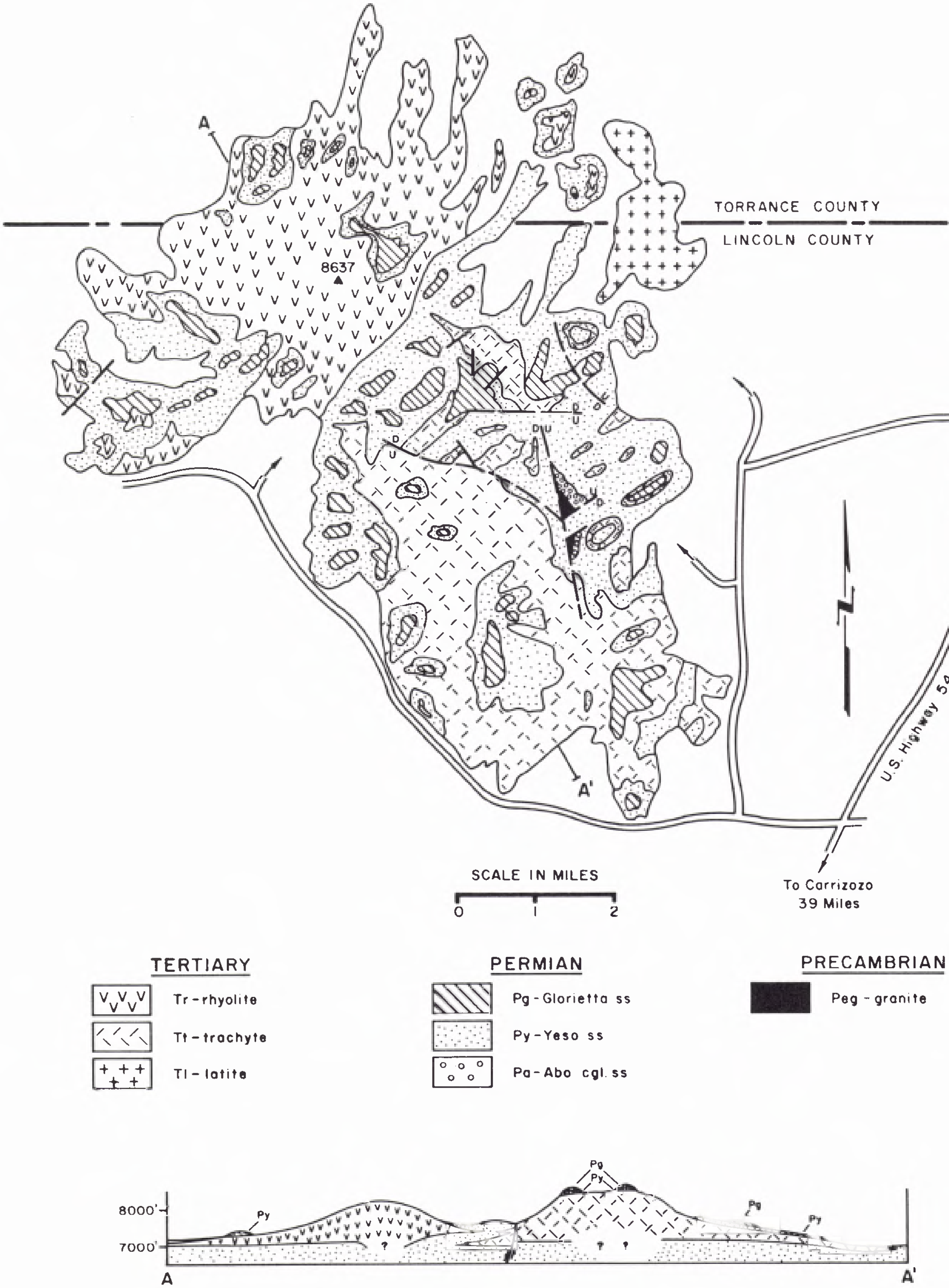


Figure 1. — Geologic map of the Gallinas Mountains, New Mexico.

only 20 to 40 feet thick, the arkose is the most distinctive member. It is granitic in composition and were it not for the few rounded schist and quartz pebbles, it could easily be mistaken, in the field, for a true granite. However, its clastic texture is apparent in thin section. Overlying the arkose is a member consisting of siltstone and shale with many interbedded lenses of conglomerate and coarse sandstone. This entire member is noticeably red and feldspathic. Schist and quartzite fragments are common also in this unit.

### Yeso Formation

Conformably overlying the Abo is the Yeso Formation. This is both the thickest (about 1,500 feet) and most extensive sedimentary rock unit in the Gallinas Mountains. Although the Abo-Yeso contact is arbitrary, the upper Yeso boundary is clearly marked by the distinct Glorieta quartzose sandstone.

Within the Yeso Formation, fine-grained feldspathic sandstone is the most abundant lithologic type, comprising over 90 percent of the formation. The remainder is dolomitic limestone, shale, siltstone, and one gypsum bed (occurring only at the south end of the range). The fine-grained feldspathic sandstone is buff-colored. Individual grains, which are cemented by a clay-limonite matrix, are sub-rounded and generally well-sorted. Cross-bedding occurs at several places in the Yeso and the uppermost beds contain oscillation ripple marks.

Most specimens of Yeso sandstone contain over 75 percent quartz, about 10 to 15 percent feldspar, and 5 percent matrix. The remainder of the rock consists of chert and some accessory minerals. Composition differs throughout the formation, although compositional variations are not random. For example the upper Yeso is generally more quartzose and less feldspathic than the lower part, and the amount of clayey matrix diminshes upwards. Not only are mineralogical changes evident, but textural differences are also apparent. Grains are more rounded and better sorted higher in the section, and quartz overgrowths are more abundant in the upper beds.

Dolomitic limestone is the second most abundant lithologic type within the Yeso Formation. This carbonate rock occurs as small, thin discontinuous lenses which are rarely continuous for more than a few tens of feet, the one exception being a 3- to 6-foot thick bed about 40 feet below the Yeso-Glorieta contact. Dolomitic limestone occurs persistently throughout the Gallinas Mountains at this particular stratigraphic position, and individual lenses are commonly continuous for hundreds of feet.

### Glorieta Sandstone

The distinctive Glorieta quartzose sandstone conformably overlies the Yeso Formation and is the youngest sedimentary unit present in the Gallinas Mountains. Its thickness is indeterminable because it is the highest stratum in this area. At least 250 feet are exposed in the Gallinas Mountains; in nearby areas, the Glorieta is nearly 300 feet thick.

In the Gallinas Mountains the Glorieta is a light-colored orthoquartzite containing as much as 97 percent quartz. Most specimens examined consist of quartz and minor amounts of feldspar and chert. The abundance of quartz overgrowths is a distinctive feature of this rock. These overgrowths have given the rock an interlocking texture which accounts for its extreme toughness. It is an excellent marker for stratigraphic and structural purposes because of its generally uniform characteristics.

The most striking difference between the Yeso and the overlying Glorieta Sandstone is the quartzitic nature of the Glorieta. Quartz grains in the sandstones of both formations exhibit solution and reprecipitation phenomena as shown by corrosion of, and deposition of overgrowths on individual quartz grains. The better sorting and lack of matrix in the beds of Glorieta Sandstone, however, enable the individual overgrowths on the grains to coalesce and to form the interlocking texture of orthoquartzite. The fact that the Glorieta is orthoquartzitic throughout much of New Mexico suggests that the quartz overgrowths are probably diagenetic rather than a local phenomena caused by igneous activity and deformation of the Gallinas Mountains.

### Sedimentary Petrogenesis of the Paleozoic Rocks

The basal arkosic member of the Abo is clearly derived from a granite and it's texture and freshness of it's components indicate little transportation. Therefore, the lower member of the Abo is simply a grus into which some exotic material has been introduced. The irregular distribution of rock types, both laterally and vertically, in the upper part of the Abo indicates that it is a flood plain deposit. Siltstone is the most abundant rock in the upper Abo; however, lenses of sandstone and conglomerate, possibly representing paleo-stream channels, appear at different horizons. The proximity to source is indicated by the local abundance of conglomerate and fresh biotite schist fragments. Apparently a typical crystalline complex, consisting of granite and metamorphics, was the source area for the Abo.

A non-marine environment for most of the Yeso is suggested by the presence of red beds and by the lack of fossils and absence of extensive carbonate and evaporites so typical of the lagoonal and definite marine Yeso to the south. The presence of oscillation ripple marks and cross-bedding and the excellent sorting of grains suggest that the upper Yeso may be a beach sand. If so, then most of the Yeso is non-marine. An occurrence of non-marine Yeso in the Gallinas area is compatible, of course, with the regional northerly facies changes of the Permian sediments in New Mexico.

According to Needham (1942, p. 36), the Glorieta is a near-shore marine deposit laid down by an advancing sea prior San Andres time. The Gallinas stratigraphy supports this concept. With an overlying marine limestone and an underlying beach sand, a near-shore environment for the Glorieta is quite likely.

Therefore the lithology of the Paleozoic rocks in the Gallinas Mountains is suggestive of a transgressive sequence: basal arkose (lower member of the Abo) grading through feldspathic sandstone (upper member of the Abo and the Yeso Formations) into relatively pure quartz sandstones (Glorieta Sandstone). The transgressive nature of this sequence of rocks becomes even more suggestive when it is recalled that a marine limestone (San Andres Formation) probably overlay the Glorieta at one time in what is now the Gallinas Mountains.

(Erosion, however, has removed all San Andres from the mountains so that it now overlies the Glorieta only in adjacent areas.) Apparently throughout Abo and Yeso time, the Gallinas Mountains area became progressively closer to a shore line and by late Yeso time, the shore line was in the vicinity of the range. Admittedly, local shore line fluctuations may have occurred in late Yeso time. The persistent limestone in the upper Yeso may well be a deposit from such a local advance and retreat of the sea prior continuous marine innundation. Continuous marine deposition probably began during Glorieta time. In general, the Gallinas sedimentary geology supports the concept of a northerly advancing sea during early Permian time.

## Tertiary Igneous Rocks

Nearly half the Gallinas Mountains is directly underlain by igneous rocks that occur in several laccoliths, dikes, sills, and one stock. Many textural, mineralogical, and chemical features suggest that the major intrusives are consanguinous and crystallized, at a relatively shallow depth, from a highly fluid subsilicic alkalic magma. This magma differentiated prior to emplacement, into trachyte, rhyolite and latite. Subsilicic alkalic stocks and hypabyssals are not restricted to the Gallinas Mountains; they are characteristic of many of the Lincoln County intrusives. The exact depth at which the Gallinas rocks solidified has not been determined; however, structural and stratigraphic studies suggest that the sedimentary cover did not exceed 1,500 to 2,000 feet.

### Porphyritic Trachyte

A laccolith of alkalic porphyritic trachyte occurs in much of the southeastern part of the Gallinas Mountains. The magma was intruded conformably into the Yeso Formation, the upper contact generally being 50 to 75 feet below the upper Yeso carbonate member. Locally, apophyses from the laccolith invade the Yeso and Glorieta at different levels.

The trachyte is a light-gray rock with prominent phenocrysts (orthoclase and/or albite) set in an aphanitic groundmass. Essential minerals are albite, orthoclase, and hornblende or aegirine-augite. An average composition is: 68 percent orthoclase, 25 percent albite, 4 percent mafics, and 3 percent accessories. The presence of riebeckite is significant in that it reflects the alkalic nature of the magma. The alkalic character is also indicated by other accessory minerals, by abundant albite and albitization, and by chemical composition.

A characteristic feature of the rock is the albitized phenocrysts. The phenocrysts are albitized orthoclase and plagioclase (albite) with albitized orthoclase overgrowths. Much of the feldspar may thus be classed as alkalic feldspar which is a replacement perthitic intergrowth.

Within the trachyte are a few occurrences of a microsyenite phase. The two rocks are similar mineralogically except for more mafics (aegirine and aegirine-augite) in the syenite. The most striking difference, however, is the phaneritic texture of the syenite. Although the origin of this minor phase is obscure, it may be related to local viscosity differences within the trachyte magma.

### Porphyritic Rhyolite

Underlying much of the northwestern part of the range is an alkalic porphyritic leuco-rhyolite. Like the trachyte, the rhyolite was intruded as a conformable sheet which thickens in its central part to form a laccolith. The rock is light-colored, extremely fine-grained, and porphyritic. Locally, miarolitic cavaties, lined with quartz or kaolinized feldspar, are present. The mineralogy is simple: orthoclase, albite, and quartz, plus accessories. Like the trachyte, deuteric and hydrothermal alteration are common. Most potash feldspar is albitized.

The rhyolite composition is quite variable. For example, albite ranges from 4 to 26 percent. A typical specimen contains about 70 percent orthoclase, 15 percent quartz, 10 percent albite, 2 percent mafics, and 3 percent accessories.

### Other Igneous Rocks

Porphyritic latite occurs only at a small isolated mountain (Cougar Mountain) immediately north of the main Gallinas range. Although contact relations are obscure, the Yeso beds a few hundred yards west of the latite are horizontal and do not change attitude near the intrusive. Thus the intrusive appears to be a small stock. The rock is distinctive. Hornblende and large oligoclase phenocrysts are set in a light gray aphanitic ground mass consisting almost entirely of orthoclase, minor quartz, and accessories. The rock composition is: 50 percent oligoclase, 45 percent orthoclase, and 5 percent hornblende.

A small porphyritic andesite dike crops out near the center of the Gallinas Mountains. This dike is about 5 feet wide and probably not over a couple hundred feet long. It is the only andesite occurrence in the area.

A peculiar brecciated rock occurs at five places in the mountains. These bodies may be pipe-like as suggested by the fact that they are nearly circular plan view. The rock consists of a trachyte matrix into which are set angular rock fragments of shale, sandstone, limestone, andesite(?), granite, and mainly trachyte. Tentatively, these small bodies are classed as erruptive breccia pipes.

### Age of the Intrusives

Unfortunately, the intrusives can be dated only as post-Glorieta. An early Tertiary age for the intrusives seems reasonable by comparisons with other areas and by relating the igneous activity to the structural deformation. One point in support of an early Tertiary age is the similarity between the central New Mexico intrusive belt in Lincoln County and the Tertiary petrographic provinces in Montana, Colorado (transverse porphyry belt), and Texas (Big Bend). The four areas all contain subsilicic and alkalic rocks. Hypabyssals (particularly laccoliths) are common. Mineral deposits are associated with the intrusives. Finally, all areas are along or near the eastern margin of the Rocky Mountain deformed belt. Because of these similarities, perhaps a distinct subsilicic and alkalic petrographic province may exist in central New Mexico.

## CONTACT METAMORPHIC ROCKS

Contact metamorphism is rare. Even limestone in direct contact with igneous rock typically is not even recrystallized, let alone metasomatically altered. Exceptions do exist and at a few localities, limestone was converted to an iron-rich calcite-diopised-tremolite-quartz skarn. With the exception of one marble occurrence, rocks were not metamorphosed unless metasomatic introduction of at least silica and considerable iron (perhaps magnesia also) occurred. Thus the intrusion, ipso facto, did not alter the rocks, but rather, the contact metamorphism is related to a later stage of hydrothermal mineralization at which time the Gallinas iron-ore deposits were formed.

## STRUCTURAL GEOLOGY

The most prominent structural feature of the Gallinas Mountains is the doming associated with the igneous intrusions. The range is, therefore, a faulted double domal uplift resulting from the intrusion of a rhyolite and trachyte laccolith. The doming, the shape of the igneous masses, and the conformability of the intrusive contacts with both overlying and underlying beds indicate that the intrusives are laccoliths. Both the trachyte and rhyolite masses occur as thin sills along the edges of the range and thicken noticeably toward the central part of the igneous masses. The periphery of the trachyte is about 30 feet thick whereas the center attains a thickness in excess of 500 feet. This shape is characteristics of a laccolith. Conformability is apparent. For example, the top of the igneous mass is nearly always at the same stratigraphic horizon, but at different elevations. At the center of each crystalline mass, both the contact and attitude of the beds are horizontal. Along the flanks of the dome, the beds and contacts dip gently (10 to 15 degrees) quaquarversally. Although the igneous rocks are essentially massive, a faint foliation was seen at a few places. In every instance, the attitude of the foliation parallels that of the overlying strata. Both the trachyte and rhyolite intrusives may be pictured, therefore, as laccoliths from which minor apophyses intruded the sedimentary rocks at different stratigraphic levels.

The brittle Yeso rocks were extensively faulted and shattered as a result of intrusion and attendant doming. Most faults, both major and minor, are high-angle normal faults with some (but indeterminate) strike-slip component. The faults have a rather distinct northwest and northeast strike pattern, the former being more prominant. This domal mountain range is somewhat elliptical and has a northwest major axis. Therefore, the fact that most of the faults strike northwest is not entirely unexpected. Whether the structural trends reflect pre-existing (Precambrian) basement trends or not is a moot question.

Like the igneous activity, the structural deformation can only be dated as post-Glorieta. In nearby areas, however, similar deformation has affected Dakota rocks, hence a post-Dakota age for the Gallinas uplift is likely. The real problem is to relate the diastrophism to one of the two disturbances capable of deforming Cretaceous strata in central New Mexico: the Late Cretaceous or early Tertiary Laramide orogeny, or the later Tertiary Basin and Range disturbance. Admittedly Basin and Range deformation has affected much of southern New Mexico, but the folding and extensive intrusive activity in the central New Mexico intrusive belt is more characteristic of Laramide diastrophism.

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