

# **Preliminary Geologic Map of the Chimney Lake Quadrangle, Chaves and Otero Counties, New Mexico**

By

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*Open-file Digital Geologic Map OF-GM 190***

**Scale 1:24,000**

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# **Preliminary Geology of the Chimney Lake, Lewis Peak, Pinon Ranch and Cornucopia Canyon Quadrangles, Otero and Chaves Counties, Southeastern New Mexico**

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## **Abstract**

Preliminary geologic mapping of the Chimney Lake, Lewis Peak, Pinon Ranch and Cornucopia Canyon quadrangles in the southeastern Sacramento Mountains documents several fold and fault systems, as well as an interesting reorientation of the structural fabric of the area to the east of the village of Pinon, NM. The geology of all four quadrangles is dominated by the Permian San Andres Formation, specifically the Rio Bonito and Bonney Canyon Members. Yeso Formation is a minor component of the local geology. In addition, large tracts of eolian-derived soils cover much of the local geology. Faults and folds in the Chimney Lake and Lewis Peak quadrangles are oriented primarily northwest-southeast and are documented by off-set of the Rio Bonito-Bonney Canyon contact. In the southern quadrangles, Cornucopia Canyon and Pinon Ranch, faults are oriented closer to east-west, reflecting a change in fabric that may be attributable to transform motion on some faults that is not easily recognized in the field or to decoupling of San Andres structures from deeper and older structures. In comparison to quadrangles to the north, the Rio Bonito Member thickens substantially to the southeast. The Bonney Canyon Member may thicken as well, though no complete sections were observed. The Glorieta sandstone tongue pinches out in the northernmost part of the Chimney Lake quadrangle and a thin, poorly exposed, silica-rich sandstone occurs near or at the contact between the Rio Bonito and Bonney Canyon Members.



**Figure 1. Clouds on Pinon Creek Escarpment.**

## **Introduction**

Kelley mapped the Sacramento Mountains and published a report and multiple maps in 1971. This report accompanies four quadrangles in the southeastern Sacramento

Mountains that have been re-mapped in an effort to refine our understanding of local geology. Clockwise from the northwest, these quadrangles are: Chimney Lake, Lewis Peak, Pinon Ranch and Cornucopia Canyon. Geographically, this area is south of Dunken and east of Pinon, New Mexico and cover parts of both Otero and Chaves counties. Geology in the area is dominated by the Rio Bonito (Psr) and Bonney Canyon (Psb) Members of the San Andres Formation, which are Permian in age. Minor exposures of Yeso Formation are present in some places, and the Yeso Formation has proven extremely useful for documenting not only fault motion, but also thickening of the Rio Bonito Member to the southeast. In addition to Permian strata, there are large areas of Tertiary and Quaternary deposits that outline the changes in position of Pinon Creek, which runs through all quadrangles but Lewis Peak.

The landscape in the field area is a mix of steep-sided hills and cliffs of Yeso Formation and Rio Bonito Member, low rolling hills of Bonney Canyon Member, and in the center of the field area, large expanses of very low-relief Quaternary deposits. Local topographic features include Chimney Peak and One Tree Peak on the southern end of the Dunken Uplift in the northwestern field area, the Pretty Bird Hills and Lewis Peak in the northeastern area, two escarpments in the eastern and central field area, and the Collins Hills in the southern field area. The northwest-southeast trending escarpment that parallels a long segment of Pinon Creek is referred to here as the Pinon Creek escarpment. The north-south trending cliffs along Lewis Canyon is referred to as The Rim and is the northern segment of the Buckhorn escarpment.

Fieldwork was conducted by standard methods, except in the few cases where land owners could not be contacted for permission or chose not to grant permission – in these instances, geologic data was obtained and extrapolated from previous geologic maps, air photography and adjacent geology.

## **Unit Descriptions**

### **Quaternary**

Quaternary units in the map area consist of modern fluvial deposits (Qal), eolian sheet silts and fine sands (Qes), colluvial fans (Qc), flat-topped and coarse-grained terraces (Qt) and rare lacustrine deposits (Ql). Qal deposits consist of cobbles and boulders of San Andres limestone and Yeso sandstone and dolomite that are within defined, modern fluvial channels. Often these channels are incised deeply into surrounding sediments and rock, and can be over 3 m in depth. All deposition in these channels is flashy, with no current perennial flow. Qes deposits are comprised of wind-born fine sand and silt that are deposited across the landscape, often by being caught in grasses and other vegetation. Qes deposits also tend to occur in sheltered bowls high up in bare bedrock exposures. Qes deposits are typically internally stratified with thin beds, but have no cross-bedding as might be expected if there was significant fluvial reworking of these deposits. Often, pebbles (and more rarely cobbles) of limestone, sandstone and dolomite are present due to eolian deposition blanketing Tertiary gravel deposits, or Quaternary colluvial fan surfaces. Near fluvial channels, it might be expected that these fine grained units would represent floodplain deposition, but examination of these sediments makes this an unlikely process as all fluvial channels examined are incising rapidly into pre-existing

strata and the fine grained deposits lack sedimentary features expected of floodplain or fluvial deposition.



**Figure 2. Thick Qes deposits on Rio Bonito Member.**

Qc deposits consist of cobbles and boulders shedding off of exposures of Permian bedrock. Along the The Rim, an escarpment in the eastern half of the Pinon Ranch quadrangle, Qc deposits are thick and quite long, often extending away from the escarpment for 1-2 km. Qt deposits are thick, very coarse grained and flat-topped, but are rare in these quadrangles. These terraces are usually covered with thick vegetation, making determination of any internal sedimentary structures difficult. The few terraces preserved in the map area lie effectively parallel to the modern day Pinon Creek. Ql deposits occur in large, naturally occurring lakes, though all of these lakes are currently dry. Fine grained, laminated mudstones and siltstone appear to be the dominant deposits in these areas. Several of these lakes have been altered from their natural dimensions.



**Figure 3. Thick Qc deposits along base of The Rim.**

### **Tertiary**

Only one Tertiary unit, Tertiary gravel deposits (Tg), has been documented in the map area. Tg deposits are located along the course of Pinon Creek, can be up to 20 m thick and consist of pebble to cobble conglomerates interbedded with fine sandstone beds and lenses. Pebbles and cobbles in these sediments are rounded to well-rounded and are primarily San Andres limestone. The sandstone intervals have cross-bedding or ripple cross-lamination, indicating fluvial deposition. These sediments are poorly lithified with a relatively young calcium carbonate cement. Locally these deposits are tilted, reflecting potentially very recent tectonic changes in the southern Sacramento Mountains.



**Figure 4. Tilted Tg deposits along Pinon Creek.**

### **Permian**

Two Permian units are exposed in the map area, the San Andres Formation and the older Yeso Formation. Two of the three members of the San Andres Formation are present, the lowest Rio Bonito Member and the middle Bonney Canyon Member. No exposures of the upper Fourmile Draw Member were seen. The Rio Bonito Member (Psr) is 100 – 200 m (300 – 600 feet) thick with a dramatic increase in thickness occurring to the southeast. It is comprised primarily of medium bedded dark gray micrite to wackestone with local beds of packstone occurring in the upper third of the unit. In the lower third, the Rio Bonito Member is locally thick bedded, though laterally these beds often thin. Fossils found in the Rio Bonito Member include solitary rugose corals, crinoids, high-spired gastropods, large nautiloids attributed to *Domatoceras*, productoid brachiopods that include both Dictyoclostids (larger specimens) and Marginiferids (smaller specimens), the brachiopod *Neophricadothyris*, and euomphalid gastropods that are nearly planispiral (B. Kues, pers. comm.). Within the lower third of the Rio Bonito Member is the Glorieta Sandstone, which occurs only in one small area in the northern part of Chimney Lake quadrangle. The Glorieta here is a quartz arenite that is gold in color, medium grained with well-rounded and well sorted grains and 0.5 m thick.





**Figure 5. Thick beds in lower Rio Bonito Member.**



**Figure 6. Fossils in Rio Bonito Member.**

The Bonney Canyon Member (Psb) of the San Andres Formation consists of medium to thin bedded pale tan dolomites with no obvious fossil material and is up to 250 feet thick, though no complete sections were observed. This unit tends to occur as outcrops of low relief, draped with moderately thick colluvial material and deeply incised by modern fluvial channels. Medium to large chert nodules are abundant in the Bonney Canyon Member and they range in color from white to yellow, orange, red and dark purple. Near

the top of the unit, striped cherts become very common and are usually combinations of black and white, red and white or red and yellow. Rarely, thin lenses of bright yellow, poorly consolidated fine grained sandstone occur. At or near the contact between the Rio Bonito and Bonney Canyon Members is a thin ( $<0.5$  m) sandstone that is massive, medium grained, moderately well sorted, with subrounded grains that is silica cemented. Locally this unit appears to be replaced with chert. Rarely, well-preserved fossil material can be found in this unit.



**Figure 7. Bonney Canyon Member outcrop.**



**Figure 8. Chert in Bonney Canyon Member.**

The Yeso Formation (Py) sits below the Rio Bonito Member and the contact is variously defined as the last occurrence of a bright yellow medium grained quartz sandstone that is massive or thin-bedded, or the last occurrence of yellow or red mudstone. Yeso strata are locally predominantly yellow and red mudstones, with lesser yellow sandstone and pale tan dolomites with occasional fossil material. Exposures of Yeso strata show a minimum of ~150m (~450 ft) of strata, though the Yeso is considerably thicker. Yeso outcrops are often draped with thick colluvial cover from the overlying Rio Bonito Member, making description of the unit difficult. To the southeast, the brilliant yellow and red mudstones

become more drab, with pale purple to gray colors predominating. Very little gypsum was seen in the map area, though the upper Yeso is noted for having less gypsum than lower Yeso Formation (Kelley, 1971).



**Figure 9. Interbedded dolomite and muddy sandstone in Yeso Formation.**



**Figure 10. Yeso Formation at the base of The Rim.**

### **Structural Features**

In the northern quadrangles (Chimney Lake and Lewis Peak), faults and folds are oriented approximately northwest-southeast, following the trends observed in quadrangles to the north (e.g. Elk, Thimble Canyon quadrangles). In the western half of the Chimney Lake quadrangle, two faults that are down to the west place the Bonney Canyon below outcrops of the Rio Bonito Member. East of these two faults, a third fault that is down to the east places Bonney Canyon outcrops below Rio Bonito Member exposures, creating a horst of Rio Bonito strata (including One Tree Peak and Chimney Peak). This is the southernmost extension of the Dunken Uplift, described by Kelley (1971). Interestingly, on the Chimney Lake quadrangle, the uplift is bounded by faults,



rather than two synclines as Kelley (1971) documented to the north. The southernmost tip of this uplift is cut by 3, possibly 4, faults that trend in a more west-east direction, and place Bonney Canyon exposures below Rio Bonito outcrop. To the east, two additional faults are present, one trending approximately along Champion Canyon that is down to the west and the other paralleling it to the east, which is down to the east.



**Figure 11. Southern end of Dunken Uplift, view from the east.**

In the western part of Lewis Peak quadrangle, a monocline (possibly faulted) brings Bonney Canyon strata down below Rio Bonito exposures. A series of poorly defined folds deform strata from west to east to the Pretty Bird Hills, where two faults, running northwest-southeast create a horst of Rio Bonito strata. The northeastern corner of the quadrangle is dominated by exposures of the Bonney Canyon Formation. In the southwestern corner of the Lewis Peak quadrangle, a portion of the Pinon Creek escarpment (trending northwest-southeast) reveals at least two down to the southwest faults that place Rio Bonito Member strata below upper Yeso Formation.

To the south, a distinct change in orientation of faults and folds takes place as one crosses over the Pinon Creek escarpment. Orientations in the Cornucopia Canyon and Pinon Ranch quadrangles are directed almost west-east. At least 4 faults cross these two quadrangles through the Collins Hills region in a series of horsts and grabens. Several smaller faults splay from and join to these larger faults, creating small “islands” of outcrop, often of Bonney Canyon strata. Unfortunately, fault plane exposures are usually very poor, with no obvious slickenplanes or slickenlines observed. Often, the fault plane itself is completely covered with Quaternary material and traces must be measured on air photos.

In the easternmost portion of the Pinon Ranch quadrangle, The Rim is the northern extension of the Buckhorn escarpment and consists of a series of 3 or 4 down to the west faults that progressively drop Rio Bonito and Bonney Canyon strata down below Yeso Formation. Three of these faults create a series of little hills along the base of The Rim,

each consisting of either Yeso Formation capped by lowermost Rio Bonito Member, or Rio Bonito Member distorted in small structural domes. In the northeastern corner of the Pinon Ranch quadrangle, The Rim faults splay, with some trending northwest, creating the Pinon Creek escarpment. At least one fault continues northward, through Lewis Peak, creating the local uplift of the Pretty Bird Hills.



**Figure 12. Offset Rio Bonito capping Yeso Formation along The Rim.**



**Figure 13. View east to The Rim.**

The rather abrupt change in structural fabric from northwest-southeast trending to west-east trending may reflect transform motion along some of these faults that is not obvious from field observations. Kelley (1971) chose not to project the Y-O Buckle fault system into this area, and indeed, there is no clear trace of this strike-slip fault system into the Lewis Peak quadrangle. However, the expression of the Y-O Buckle may simply be more subtle in this region and observable only as a reorganization of fault trends to the south. Alternatively, the difference between the structures in the northern and southern map areas may also be related to differences in structures in much older rocks in the subsurface or to dislocation of motion between these older structures and the San Andres Formation. The Yeso Formation, with its great thickness of mudstone and gypsum, is a

less competent unit than underlying and overlying thick limestone units, such as the San Andres Formation. Thus, fault motion along deeper structures may not translate upwards into the San Andres, but there may be a decoupling of older strata from the San Andres, caused by the intervening Yeso Formation. Clearly, this hypothesis needs further exploration by examining subsurface data, where available.



**Figure 14. Fault in Barclay Draw with no apparent vertical offset.**

### **Tertiary and Quaternary Deposition**

Chimney Lake, Lewis Peak and Pinon Ranch quadrangles are notable for the large expanses of Tertiary and Quaternary deposits that cover San Andres strata. The modern Pinon Creek drainage area covers large parts of both the Chimney Lake and Pinon Ranch quadrangles, along with thick deposits of Tertiary gravels, Quaternary eolian soils and colluvial deposits along both escarpments. Currently, Pinon Creek runs south of the southernmost edge of the Dunken Uplift, parallel to the Pinon Creek escarpment before turning south to parallel Lewis Canyon and The Rim. A broad valley separates a small outcrop of Rio Bonito exposures from the rest of the Dunken Uplift to the north and this valley is probably a Pinon Creek paleovalley. Gravel deposits are much less evident in this paleovalley than they are in the modern valley, though this is probably due to the thick drape of eolian soil that blankets the area. Thick deposits of Tertiary gravels occur along the modern Pinon Creek, sometimes recognizable as flat-topped terraces. Usually gravels occur as low, elongate mounds, covered with vegetation. Where dissected by modern fluvial channels, these gravels show internal stratification, including sandstone beds and lenses, indicating fluvial deposition. Unfortunately, these strata were not exposed in three dimensions, so no cross-bed orientations or other flow direction indicators could be observed.



**Figure 15. Tertiary fluvial deposits exposed in wall of modern fluvial channel.**

### **Conclusions**

The four quadrangle area documented here contains both an interesting Tertiary-Quaternary story in terms of the changes in the Pinon Creek drainage system and a fascinating change in structural fabric between the northern field area, where structures are oriented northwest-southeast and the southern field area, with faults oriented in a more west-east direction. Further research in this area will focus on identifying possible transform motion along some of the larger fault systems. In addition, further exploration of the relationship between surface expression of structure and deeper fault systems along the western edge of the Permian basin is needed, including understanding possible decoupling of older rocks from the San Andres Formation by the presence of less competent Yeso strata.

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### **Reference**

Kelley, V.C., 1971, Geology of the Pecos country, southeastern New Mexico: New Mexico Bureau of Mines and Mineral Resources, Memoir 24, 78 p.



## **Chimney Lake Unit Descriptions:**

### Quaternary

**Qal Alluvium** - cobbles and pebbles of limestone in modern fluvial channels, incised into surrounding strata.

**Qes Eolian Sheet** - eolian silt, internally stratified, common pebbles and cobbles of limestone. Can be up to 4-5 m thick.

**Ql Lacustrine** – modern lake deposits, laminated mud and clay.

### Lower Permian

**Psb Bonney Canyon Member, San Andres Formation** - Thin to medium bedded tan dolomite. Common chert that is white, yellow, red, orange and purple in color.

**Psr Rio Bonito Member, San Andres Formation** - Medium to occasionally thick bedded dark gray micrite to wackestone, with packstone occurring in upper third. 0.5 m thick tongue of Glorieta Sandstone occurs rarely: gold, medium grained, well sorted, well rounded quartz arenite.

**Py Yeso Formation** - Bright yellow and red mudstone interbedded with thin pale brown dolomite beds and medium beds of sandstone (massive to thin bedded).

## **Cornucopia Canyon Unit Descriptions:**

### Quaternary

**Qal Alluvium** – cobbles and pebbles of limestone in modern fluvial channels, incised into surrounding strata.

**Qes Eolian Sheet** - eolian silt, internally stratified, common pebbles and cobbles of limestone. Can be up to 4-5 m thick.

**Qt Terrace** – terrace deposits along the modern-day course of Pinon Creek. Flat topped, thick deposits of pebbles and cobbles. Up to 4-5 m thick.

### Tertiary

**Tg Fluvial gravel** – gravels deposited by Pinon Creek. Interbedded cobble and pebble conglomerate and medium grained quartz sandstone with cross-bedding or ripple cross-lamination. Up to 20 m thick.

### Lower Permian

**Psb Bonney Canyon Member, San Andres Formation** - Thin to medium bedded tan dolomite. Common chert that is white, yellow, red, orange and purple in color.

**Psr Rio Bonito Member, San Andres Formation** - Medium to occasionally thick bedded dark gray micrite to wackestone, with packstone occurring in upper third. 0.5 m thick tongue of Glorieta Sandstone occurs rarely: gold, medium grained, well sorted, well rounded quartz arenite.

**Py Yeso Formation** - Bright yellow and red mudstone interbedded with thin bedded pale brown dolomite.

## Lewis Peak Unit Descriptions:

### Quaternary

**Qal Alluvium** – cobbles and pebbles of limestone in modern fluvial channels, incised into surrounding strata.

**Qes Eolian Sheet** - eolian silt, internally stratified, common pebbles and cobbles of limestone. Can be up to 4-5 m thick.

**Ql Lacustrine** – modern lake deposits, laminated mud and clay.

### Lower Permian

**Psb Bonney Canyon Member, San Andres Formation** - Thin to medium bedded tan dolomite with rare lenses of yellow fine grained quartz sandstone. Common chert that is white, yellow, red, orange and purple in color.

**Psr Rio Bonito Member, San Andres Formation** - Medium to occasionally thick bedded dark gray micrite to wackestone, with packstone occurring in upper third. 0.5 m thick tongue of Glorieta Sandstone occurs rarely: gold, medium grained, well sorted, well rounded quartz arenite.

**Py Yeso Formation** - Bright yellow and red mudstone interbedded with thin bedded pale brown dolomite and gold sandstone (thin bedded or massive).

## **Pinon Ranch Unit Descriptions:**

### Quaternary

**Qal Alluvium** – cobbles and pebbles of limestone in modern fluvial channels, incised into surrounding strata.

**Qes Eolian Sheet** - eolian silt, internally stratified, common pebbles and cobbles of limestone. Can be up to 4-5 m thick.

**Ql Lacustrine** – modern lake deposits, laminated mud and clay.

**Qt Terrace** – terrace deposits along the modern-day course of Pinon Creek. Flat topped, thick deposits of pebbles and cobbles. Up to 4-5 m thick.

### Tertiary

**Tg Fluvial gravel** – gravels deposited by Pinon Creek. Interbedded cobble and pebble conglomerate and medium grained quartz sandstone with cross-bedding or ripple cross-lamination. Up to 20 m thick.

### Lower Permian

**Psb Bonney Canyon Member, San Andres Formation** - Thin to medium bedded tan dolomite. Common chert that is white, yellow, red, orange and purple in color.

**Psr Rio Bonito Member, San Andres Formation** - Medium to occasionally thick bedded dark gray micrite to wackestone, with packstone occurring in upper third. 0.5 m thick tongue of Glorieta Sandstone occurs rarely: gold, medium grained, well sorted, well rounded quartz arenite.

**Py Yeso Formation** - Drab purple mudstone interbedded with thin bedded pale brown dolomite and gold sandstone (thin bedded or massive).