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THE CHESS DRAW DEPRESSION, OTERO CO., NEW MEXICO: A HYDROTHERMALLY-ALTERED, SUBLACCOLITHIC, ALKALIC SYSTEM

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ABSTRACT.—The Tertiary alkalic intrusives of the Cornudas region of west Texas and southern Otero County, New Mexico, represent reasonable exploration targets rare earth elements, beryllium, and other metals. Erosionally resistant, unaltered intrusives are prominent on the landscape and have been extensively studied. This report presents data indicating that other portions of the intrusive complexes are also present in the region, but they form negative physiographic features. Three drill holes into the Chess Draw Depression, northwest of Wind Mountain, provide the evidence for the interpretation that Chess Draw is an example of a negative topographic feature caused by extensive hydrothermal alteration.

INTRODUCTION

The alkalic intrusives on the north central Diablo Plateau, known as the Cornudas Mountains are prominent and erosionally resistant hills. They can be seen north of the Highway 180 between E1 Paso and Carlsbad. These plugs, laccoliths and sills have been radiometrically dated to be 33 to 37 million years old and have been subjected to numerous other geological, geochemical and petrologic studies (Barker and Hodges, 1977, Barker et al., 1977, Henry and McDowell, 1986; Price et al., 1986; McLemore and Guilinger 1993, 1996; McLemore et al., 1996; Nutt and O'Neill, J., 1998). This group of intrusives bears some resemblance to those near the Sierra Blanca, Texas, 90 km to the south. Sierra Blanca contains proven resources of beryllium (Henry, 1992; Price et al., 1990; Shannon and Goodell, 1986; Matthews and Adams, 1986; Setter and Adams, 1986). A dike containing abundant eudialyte, $Na_{15}Ca_6(Fe,Mn)_3Zr_3(Si_5O_{73})(O,OH,H_2O)_3(Cl,OH)_2$, and other Zr minerals (catapleiite, $Na_2SrSi_3O_9{\cdot}2H_2O$ and georgechaoite, $NaKZrSi_3O_9{\cdot}2H_2O$) at Wind Mountain (Boggs and Ghose, S. 1985), in addition to parakeldyshite, $Na_2ZrSi_2O_7$ (McLemore et al., 1996), also attests to the high REE and Zr potential of the area. This deposit also displays similarities to the fluorite-REE deposits in the Gallinas Mountains of Lincoln County, New Mexico.

Gold is another resource sometimes associated with alkali rocks. A gold deposit with an alkalic intrusive association is located at White Oaks, New Mexico, approximately 195 km north of the area (Fulp and Woodward, 1991). Since REE and Au deposition are sometimes associated with alkaline magmatism (Fulp and Woodward, 1991; Kogarko, 1990; Mutschler et al., 1991; Woodward and Fulp, 1991; Wyman and Kenrich, 1989), additional research on any igneous rocks in the region (especially on poorly exposed rocks such as those at Chess Draw) is important.

In 1985, a surface study and later drilling took place in the area of Chess Draw, approximately 3 miles northwest of Wind Mountain, with REE as the exploration target (Scaar, 1986). Chess Draw is a broad area of negative relief that was the site of a Holocene lake. Very little geological information can be discerned from the surface because of a lack of rock outcrop. In several places, resistant dikes are buried in the lake mud. Today they are exposed in arroyos caused by recent geomorphic rejuvenation. The drill holes reveal the startling geological relationships; beneath the geologically featureless topographic low there are extensive areas of intrusive rocks cut by multiple dikes and hydrothermal alteration.

REGIONAL GEOLOGY

The Cornudas region lies on the northern Diablo Plateau, underlain by a recognized Precambrian block that is overlain by thin veneers of Paleozoic and Mesozoic sedimentary rocks (Nutt and O'Neill, 1998). Perhaps as precursors to Tertiary rifting, the West Texas-New Mexico Tertiary alkalic igneous province developed, although others may attribute it to late Laramide subduction zone processes (see McLemore, this volume). The Cornudas intrusives, and most likely the Chess Draw igneous rocks, belong to this province. The Diablo Plateau has subsequently become an uplifted, internal block of the Rio Grande Rift that developed during the Tertiary. The plateau is bounded on the east by the Salt Graben and on the west by the Hueco Bolson.

GEOLOGY OF THE CHESS DRAW AREA

The relatively flat lying Paleozoic sediments of the Diablo Plateau, equivalent to the Hueco, Yeso and San Andres Formations of Permian age, are at the surface near the Chess Draw area, and are upturned in numerous places surrounding the Chess Draw Depression (CDD) usually in association with intrusive masses nearby. Nutt and O'Neill noted Cretaceous sedimentary rocks near some of the topographically prominent intrusions and southeast of the study area. No Cretaceous rocks are found in Chess Draw. Dikes of alkalic and syenitic compositions are found on the margins of the depression, as are several small alkalic stocks.

Some of the Tertiary alkalic intrusives are prominent on the landscape due to their freshness and resistance (e.g. Wind and Cornudas Mountains, Fig. 1). In contrast to these positive features, several areas with negative topography are present, including Chess Draw area. The Chess Draw Depression (CDD), is an unusual, broad depression in the otherwise undulating dip slope of Paleozoic sediments of the Diablo Plateau. The CDD appears

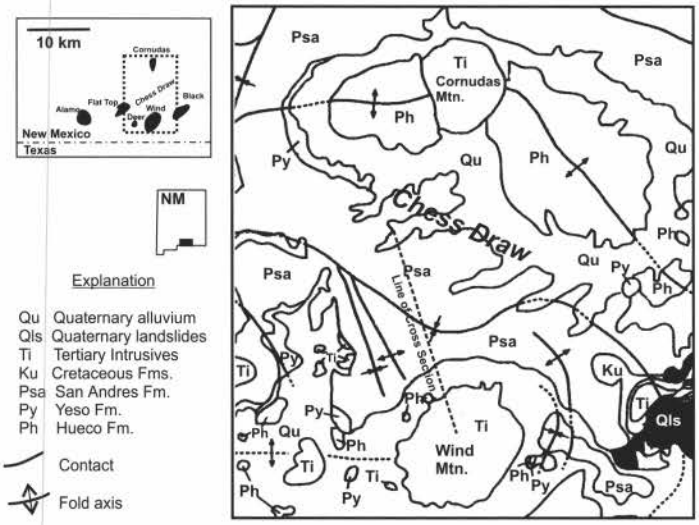

FIGURE 1. Reference maps and generalized geologic map (modified from Nutt and O'Neill, 1998) of the Cornudas Mountains area in the vicinity of Chess Draw.

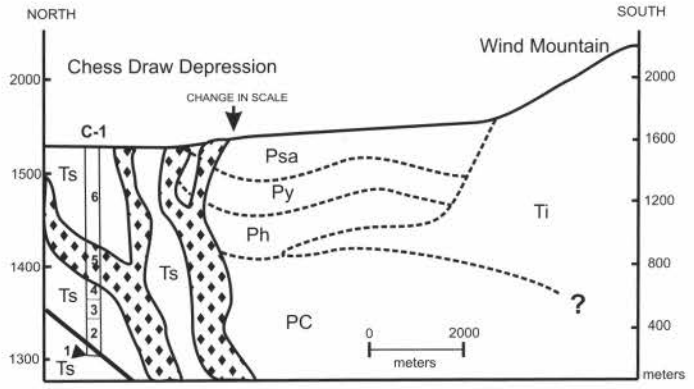

FIGURE 2. Schematic cross section trending 140° from drill hole C-1 in the Chess Draw Depression (left) to the peak of Wind Mountain. The vertical scale on the right is not exaggerated. The vertical scale on the lower left has been exaggerated five items in order to effectively show the suggested character of the intrusive bodies encountered in the drill hole. As shown, the right hand dike intruded along the contact of the syenite with the limestone host. The bold line near the lower left corner of the section represents a fault with unknown orientation and displacement. The right hand dike is assumed to have intruded along the earlier syenite-Paleozoic sediment contact. Map Symbols: **PC** = Proterozoic rocks; **Psa** = San Andres Formation; **Py** = Yeso Formation; **Ph** = Hueco Formation; **Te** = Tertiary syenite porphyry; **Td** = Tertiary dike; **Ti** = Tertiary composite intrusive of Wind Mountain. The rocks encountered in drill hole C-1 are as follows (I.C. Scarr, 1986): **1**. Contact Breccia containing metasediment and felsic volcanic material, **2.** Plagioclase - augite/hornblende syenite porphyry, syenite, (Ts), **3.** Brecciated Permian limestone and siltstone of the Hueco Formation, **4.** Plagioclase porphyry/ syenite porphyry (Ts), **5.** Brecciated igneous material (Td), dike, **6.** Plagioclase - augite/hornblende syenite porphyry (Ts).

to have been occupied by a Holocene lake and filled with up to 4 m of mud that covers most bedrock today. Occasional deep dissection in arroyos provides rare glimpses to the underlying igneous rocks in the CDD.

MINERAL EXPLORATION ACTIVITY AT CDD

Given the potential commodities to be discovered associated with these types of igneous rocks (e.g. REE and Zr), the area has been the target of some exploration efforts. The prominent, resistant intrusives are fresh, contain only rare occurrences of REE or Zr minerals and thus of little interest. Dikes, alteration, and brecciation are present in increasing abundance, respectively, in the minor intrusive outcrops in and around the CDD. Surface sampling also revealed enrichment in selected elements within the CDD. These initial results were enticing enough for U.S. Borax to engage in a drilling project in the area and drill core from three holes are currently in the possession of The University of Texas at El Paso. Drill hole C2 is located at the NW corner of section 17, T265, R14E, Otero G., NM. C1 is 95 m 53° W from C2, and C3 is 760 m 55° E from C2. Drilling has revealed intrusive rock types such as trachyites, syenites, phonolites, and others (U.S. Borax, 1986), and these are significantly altered in places. Mineralized veinlets contain pyrite, fluorite, pyrochlore $(Ca,Na)_2Nb_2O_6(OH,F)$), zircon, bastnäsite ($(Ce,La,Y)(CO_3)F$) and quartz (R.A. Schriner, pers. comm., 1988).

Although drill hole control consists of only three points, Figure 2 illustrates a geologic cross section derived from drilling and summarizes the results. Large amounts of porphyritic syenite are present and the degree of brecciation, number of dikes, and the extent of hydrothermal alteration are significant (Scaar, 1986). In places, alteration is widespread, with much of the core exhibiting pervasive argillic alteration. Hole C-1 bottomed in a pyritized fault gouge.

GEOCHEMISTRY

Maximum and minimum values of selected chemical concentrations, mostly REE, from drill hole samples are given in Tables 1. For comparative purposes, ranges of analytic results for the same chemical elements from nearby laccoliths in the Cornudas and Sierra Blanca, Texas, are included in Table 1. The CDD is enriched in La, with respect to nearby laccoliths and improverished in Ce, Nd, and U. Nb, Sc and Tb do not show much variation among the different intrusions. Nb, Ce, La, Th, U, and F all show strong enrichment over crustal averages. Be, Eu, Lu, Nd, Sm, Tm, Yb, show minor enrichment. Selected samples were also analyzed for gold (Scaar, 1986) although no strong anomalies were identified. R.A. Schriner of the U.S. Bureau of Mines (pers. comm., 1988), detected a high of 2,000 ppm niobium in a surface sample of a dike, considerably more than is reported in the Tables 1 and 2.

Comparison of the altered rocks in the CDD to those of a known beryllium deposit in the Trans Pecos Alkalic province, e.g. Sierra Blanca, Texas, reveals some significant similarities and differences. Calculation of enrichment factors (maximum concentration in sample/average value in granite) for both the rocks of the CDD and Sierra Blanca were used to make comparisons. These enrichment factors are presented in Figure 3. The fact these

Table 1. Ranges of selected chemical concentrations for lithologic samples from Chess Draw drill holes C1, C2, and C3. Also included are values from Cornudas Mountains (NM), and Sierra Blanca (TX) laccoliths and the Quitman Mountains (TX). Enrichment Factor: + means that some samples were > 2 times; ++ means > 10 times, no symbol means no apparent enrichment compared to average granite. All values in ppm except Ti in weight percent.

Element / Enrich-ment Factor	C-1 275 m	C-2 245 m	C-3 245 m	REE Vein Wind Mtn (1)	Cor-nudas Mtns. (2)	Wind Mtn. (3)	Quitman Mtns. (4)	Sierra Blanca, TX (5)	Ave. Gran-ite (6)
Nb ++	10 - 430	16 - 320	6 - 190		10-1400	46-448	30-82	53 - 360	20
Be	< 2-14	2-6	<2-2					1.5 - 20	5
Ce +	< 5 - 265	65-211	< 5 -225	1235			38-672	126 - 240	46
Eu +	< 1 -2	< 1- 3	< 1- 4					.18 - 1.5	1.2
Ho +	< 1 - 2	< 1 -2	2.1 - 1230.0						1.2
La +	24 - 198.0	31.6 - 126.0	< 0.1 -0.9	700		61-184	19-67	25 - 95	25
Lu +	< 1- 0.9	0.3-0.7	< 0.1 -0.9					1.5 - 8.5	.01
Nd +	< 0.5-67	26 - 73	< 5 - 93	270					28
Sc -	0.22 - 4.35	2.64 - 13.60	<0.5-14.9					.9 - 5	5
Sm +	0.3 - 10.1	4.8 - 11.5	<0.5-14.9					13-15	3
Tb	<0.5 - 1.0	<0.6-1.5	<0.5 - 1.2					1.5 - 2.6	.05
Th +	<0.5 - 64.1	7.9-33.6	< 0.5 - 20.8			8-77	1- 47	34-205	17
Tm +	<0.5-0.8	<0.5 - 1.0	< 0.3 - 1.1						0.5
Yb +	<0.5 -0.8	2.1 - 5.9	<0.5 - 4.4					15-70	.06
U ++	<0.2 - 4.0	0.2 - 3.0	0.4 - 19.0		230-13000	11-26		7.3-35	4.8
F ++	320-1800	330 - 1950	100 - 2000					600-2000	.07
Zr ++	40-2000	120 - 1400	23 -875		10-3000	744-2843	290 - 640	250 - 650	180
Ti +	0.01-0.42	0.21-0.40	.01-0.92			.08–.26	.21 - .74	.01 - .6	0.44

(1) McLemore et al. (1988)
(2) McLemore and Guilinger (1993)
(3) McLemore et al. (1996)
(4) Setter and Adams (1986)
(5) Shannon and Goodell (1986)
(7) Levinson (1980)

values represent maximum concentrations, and not large volumes of average concentration, should be noted by the reader. In the slightly enriched elements (Fig. 3A), the CDD samples are very similar to those associated with the beryllium deposit at Sierra Blanca, Texas. Significant differences are seen as the CDD is slightly enriched with respect to Zr but depleted with respect to U when compared with Sierra Blanca. In the moderately enriched elements (Fig. 3B), the two areas show marked similarity, although Sierra Blanca is significantly enriched in Tb and is depleted in La compared to drill hole C-3 at the CDD. In the highly enriched elements, Lu and Yb, Sierra Blanca is significantly more enriched compared to the drill holes in the CDD. Both rocks are highly enriched in F (not plotted) in both areas displaying enrichment factors of approximately 28,000 over average granite.

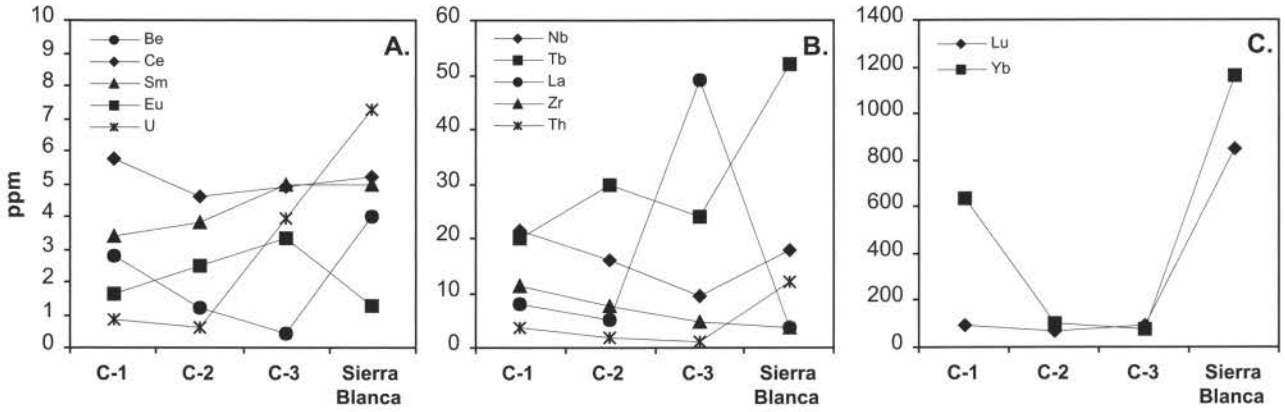

FIGURE 3. Enrichment factors for elements from the three drill holes in Chess Draw compared to lithochemical samples from Sierra Blanca, Texas (Shannon and Goodell, 1986). See text for discussion of how enrichment factors were calculated.

DISCUSSION AND CONCLUSIONS

The area of interest consists of negative topography surrounded by upturned beds cut by altered igneous dikes. Pervasive alteration, dikes, and brecciation are present in portions of the drill holes. The area of negative topography is much larger than the area drilled. A sufficient portion of the Chess Draw geomorphic depression was not drilled to effectively evaluate the economic potential of the area. It is likely that altered igneous rock such as encountered in the drill holes underlies the entire CDD. Nutt and O'Neill (1998) noted the presence of a large intrusive body in the area of Chess Draw based on magnetic data. We propose that the area of the Chess Draw depression was a volcanic vent or subvolcanic intrusion. This vent was subsequently altered by hydrothermal solutions that produced the geochemical anomalies observed. Erosion of the altered igneous rock produces the negative topographic expression.

The intent of this manuscript is to convey the fact that there has been much more hydrothermal and magmatic activity in the Cornudas area than can be seen, or has been reported in the literature. Prior studies of igneous rocks in the Cornudas are of topographic landmarks; prior studies of topographically negative areas have not been reported. Further work aims to test the presence of an igneous center at Chess Draw which has been so altered that it forms a topographic depression and to evaluate the geochemical potential of the area. The high fluorine content and vein mineralogy described in this paper are similar to the Red Cloud breccia-fluorite deposits of Lincoln County, New Mexico (Williams-Jones et al., 2000). Future exploration programs should be modeled accordingly.

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REFERENCES

Barker, D.S., and Hodges, F.N., 1977, Mineralogy of intrusions in the Diablo Plateau, northern Trans-Pecos magmatic province, Texas and New Mexico: Geological Society of America Bulletin, v. 88, p. 1428-1436.

Barker, D.S., Long, L.E., Hoops, G.K., and Hodges, F.N., 1977, Petrology and Rb-Sr isotope geochemistry of intrusions in the Diablo Plateau, northern Trans-Pecos magmatic province, Texas and New Mexico: Geological Society of America Bulletin, v. 88, p. 1437-1446.

Boggs, R.C. and Ghose, S., 1985, Georgechaoite, $NaKZrSi_3O_9 \cdot 2H_2O$, a new species from Wind Mountain, New Mexico: Canadian Mineralogist, v. 23, p. 1-4.

Fulp, M.S., and Woodward, L.A., 1991, The Mudpuppy-Waterdog Prospect, an Alkalic Copper-Gold Porphyry System in the Nogal-Bonito Mining District, Lincoln County, New Mexico: New Mexico Geological Society, 42nd Field Conference, Guidebook, p. 327-328.

Henry, C.D., and McDowell, F.W., 1986, Geochronology of Magmatism in the Tertiary volcanic field, Trans-Pecos, Texas: Texas Bureau of Economic Geology, Guidebook 23, p. 99-122.

Klein, C. and Hurlbut, C.S. Jr., 1985, Manual of Mineralogy: New York, John Wiley and Sons, p. 151-152.

Kogarko, L.N., 1990, Ore forming potential of alkaline magmas: Lithos, vol. 26, p. 167-175.

Levinson, A.A., 1980, Introduction to Exploration Geochemistry, 2nd ed., Wilmette, IL., Applied Publishers, 924p.

Matthews, W.K. III, and Adams, J.A.S., 1986, Geochemistry, Age, and Structure of the Sierra Blanca and Finlay Mountain intrusions, Hudspeth County, Texas: Texas Bureau of Economic Geology, Guidebook 23, p. 207-224.

McLemore, V.T. and Guilinger, J., 1993, Geology and Mineral Resources of the Cornudas Mountains, Otero Co., New Mexico and Hudspeth Co., Texas: New Mexico Geological Society, 44th Field Conference, Guidebook, p. 145-153.

McLemore, V.T., and Guilinger, J., 1996, Industrial specifications of the Wind Mountain nepheline-syenite deposit, Cornudas Mountains, Otero County, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 154, Geology of Industrial Minerals 31st Forum, pp. 121-125.

McLemore, V.T., Lueth, V.W., Guilinger, J.R.,. and Pease, T.C., 1996, Geology, mineral resources and marketing of the Wind Mountain nepheline-syenite porphyry, Cornudas Mountains, New Mexico and Texas, New Mexico Bureau of Mines and Mineral Resources, Bulletin 154, Geology of Industrial Minerals, 31st Forum, pp. 127-136.

McLemore, V.T., Lueth, V.W., Pease, T.C., and Guilinger, J.R., 1996, Petrology and Mineral Resources of the Wind Mountain Laccolith, Cornudas Mountains, New Mexico and Texas: The Canadian Mineralogist, v. 34, pp. 335-347.

McLemore, V.T., North, R.M. and Leppert, S., 1988, Rare-earth elements (REE) in New Mexico: New Mexico Geology, v. 10, p. 33-38.

Mutschler, F.E., Mooney, T.C., and Johnson, D.C., 1991, Precious metal deposits related to alkaline igneous rocks - A space-time trip through the Cordillera:

Bureau of Mines and Mineral Resources, Bulletin 154, Geology of Industrial Minerals, 31st Forum, pp. 127-136.

Nutt, C.J., and O'Neill, J.M., 1998, Geologic Framework of Tertiary Intrusions of the Cornudas Mountains, Southern New Mexico, New Mexico Geological Society, 49th Field Conference, Guidebook, pp. 129-134.

Price, J.G., Henry, C.D., Barker, D.S., and Parker, D.F., 1987, Alkalic rocks of contrasting tectonic settings in Trans-Pecos, Texas: Geological Society of America Special Paper, no.215, p. 335-346.

Scaar, I.C., 1986, Results of drilling the Chess Draw prospect, Otero Co., NM, unpublished report, U.S. Borax.

Setter, J.R.D., and Adams, J.A.S., 1986, Petrology and Geochemistry of the Quitman Mountains, Hudspeth County; Texas: Texas Bureau of Economic Geology, Guidebook 23, p.178-206.

Shannon, W.M., and Goodell, P.C., 1986, Lithogeochemistry of Intrusive Rocks of the Quitman-Sierra Blanca Igneous Complex, Hudspeth County, Texas: Texas Bureau of Economic Geology, Guidebook 23, p. 225-236.

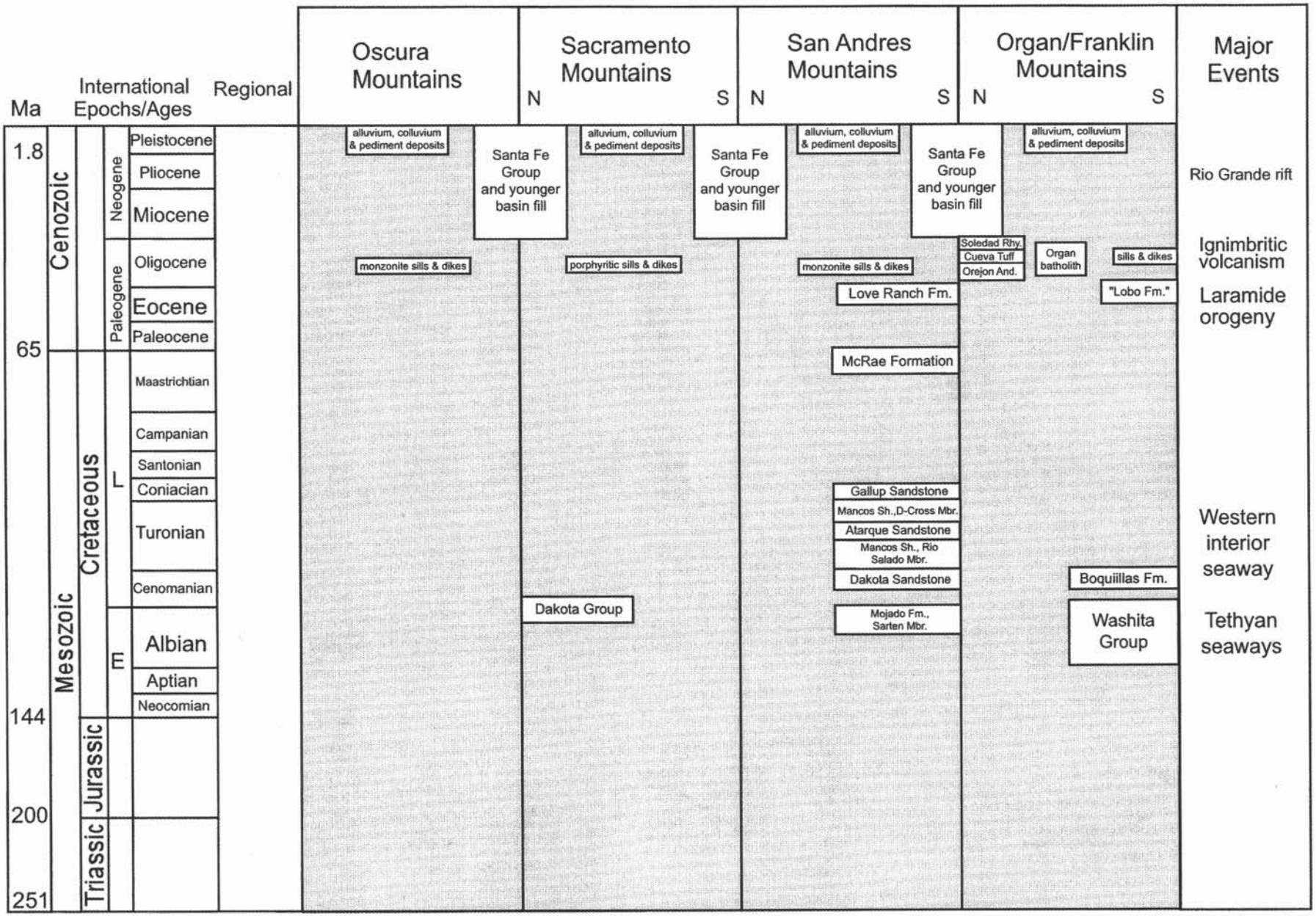
Williams-Jones, A.E., Samson, I.M. and Olivo, G.R. 2000, The genesis of hydrothermal Fluorite-REE deposits in the Gallinas Mountains, New Mexico: Economic Geology, v. 95, p. 327-342.

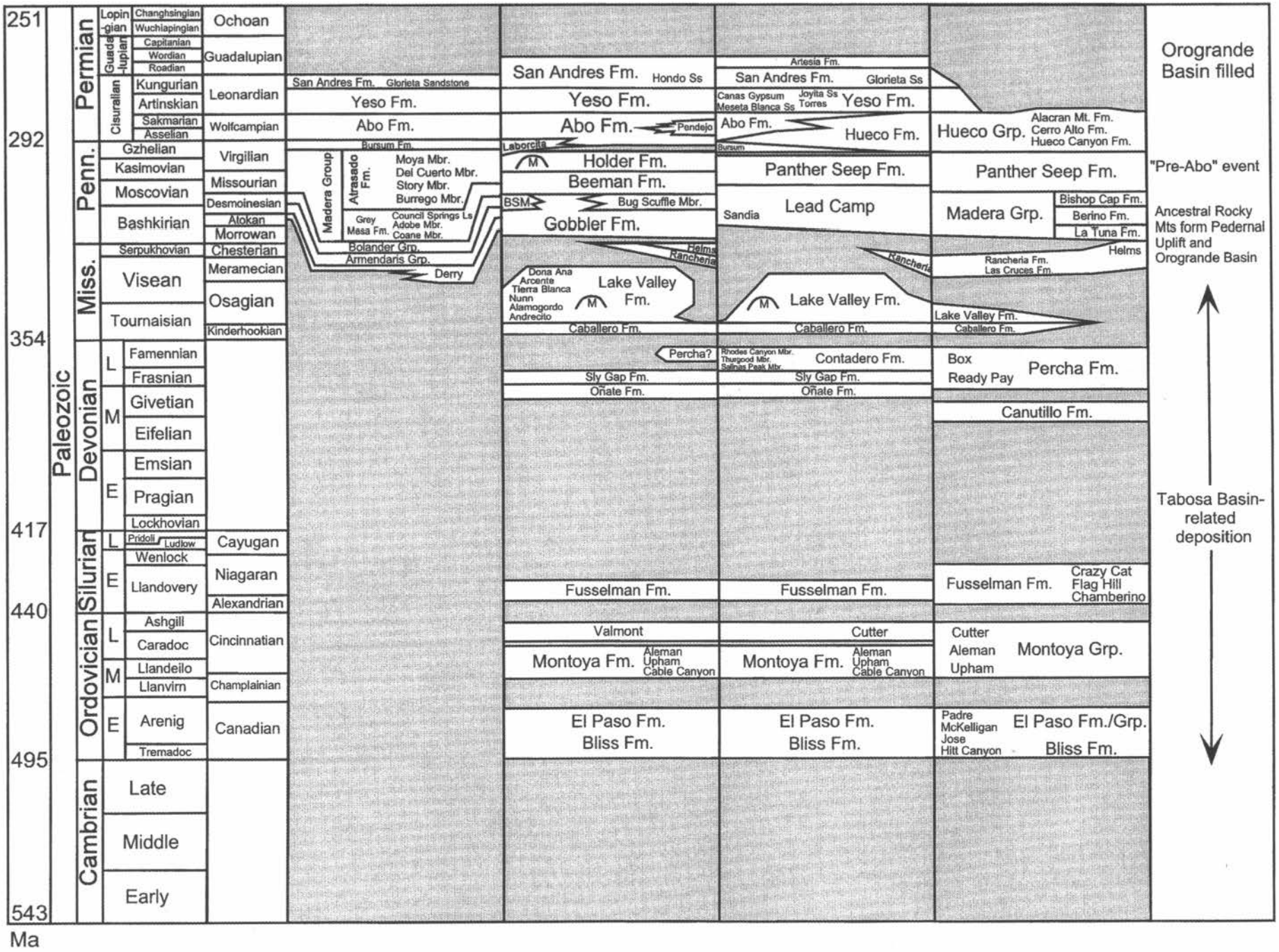
Woodward, L.A., and Fulp, M.S., 1991, Gold Mineralization Associated with Alkali Trachyte Breccia in the Gallinas Mining District, Lincoln County, New Mexico: New Mexico Geological Society, 42nd Field Conference, Guidebook, p. 323-325.

Wyman, D., and Kenrich, R., 1989, Archean Shoshonitic Lamprophyres Associated with Superior Province Gold deposits: Distribution, Tectonic - setting, Noble Metal Abundances, and Significance for Gold Mineralization: Economic Geology, Monograph 6, p. 651-667.

STRATIGRAPHIC CHART

W.D. Raatz (Paleozoic) New Mexico Bureau of Geology and Mineral Resources
S.G. Lucas (Cenozoic and Mesozoic) New Mexico Museum of Natural History





Names and ages based on IUGS data. The El Paso Fm. can alternatively be divided into units from Flower (1964), in ascending order Sierrite, Big Hatchet, Cooks, Victorio Hills, Jose, Mud Springs Mountain, Snake Hills, McKelligon, Scenic Drive, and Florida Mountains.