CORRELATION OF VOLCANIC ROCKS IN SANTA CRUZ COUNTY, ARIZONA

By

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A study of the volcanic rocks in Santa Cruz County, Arizona, has been made through compilation of previous work together with new investigations. These compilations indicate that there are many similarities of sequence and structure in the volcanic rocks of the Atascosa Mountains, Tumacacori Mountains, Santa Rita Mountains, Patagonia Mountains, and Mustang Mountains of Santa Cruz County. The volcanic rocks of the Tucson Mountains to the north of Pima County also show similarities to the volcanic rocks in the ranges of Santa Cruz County.

Previous studies were made in the Atascosa and Tumacacori Mountains by Webb and Coryell (1954). The regional geology of the Santa Rita and Patagonia Mountains was mapped by Schraeder (1915) although many localized studies have since been made by various authors. The geology of the Mustang Mountains was mapped by Bryant (1951). The Tucson Mountains have been studied principally by Brown (1939) and Kinnison (1958).

A stratigraphic column of the volcanic rocks of each range has been constructed. These columns are shown on Plate 1. The generalized sequence in each case is: Cretaceous (?) andesite and rhyolite; Tertiary andesite, rhyolite, tuff, rhyolite-latite, and andesite; and Quaternary (?) basalt.

The rocks were dated by using the principle of superposition as well as the following hypotheses: the rocks thought to be Cretaceous also are badly faulted and tilted and a pre-Laramide age is suggested; the rocks thought to be Tertiary are thick and only gently tilted so that a post-Laramide age is suggested; the upper andesites of this Tertiary sequence are not tilted, and they are probably post-Lower Miocene since they have structural and sequential similarities with the andesites associated with the Lower Miocene Minetta beds and their probable equivalent, the Pantano formation; the rocks thought to be Quaternary are relatively undisturbed and they overlie gravels and lake beds thought to be late Pliocene and Pleistocene.

It is not believed that similar flows or tuffs in different ranges belong to the same extrusion of volcanic material. Instead it is believed that widespread subterranean activity has resulted in similar extrusive expression of this activity in different areas.

Microscopic studies of each major volcanic unit shown on Plate 1 show the normal assemblage of minerals to be expected for each rock type except for the olivine basalts which all contain quartz. Some flows can be correlated between different ranges on the basis of the presence of certain recurring minerals. However, the minerals present may be common in a certain rock type in many different areas. For example, the presence of augite phenocrysts does not prove correlation of two different andesites since the mineral augite is common in andesites throughout the world.

A few intrusive bodies of the same rock type, having approximately equal times of emplacement, were noted in the various ranges as shown on Plate 1. Also the tectonic/sedimentary breccias of Kinnison (1958) and Courtright (1958) seem widespread.

Cretaceous and older rocks in this area show many northwesterly-trending structures. The Tertiary rocks are usually tilted to the north, east and northeast. The basalts are flat-lying in every instance. In a general way, there are striking structural similarities in the volcanic rocks of Santa Cruz County and the Tucson Mountains.

The association of structural deformation and volcanic activity is widely

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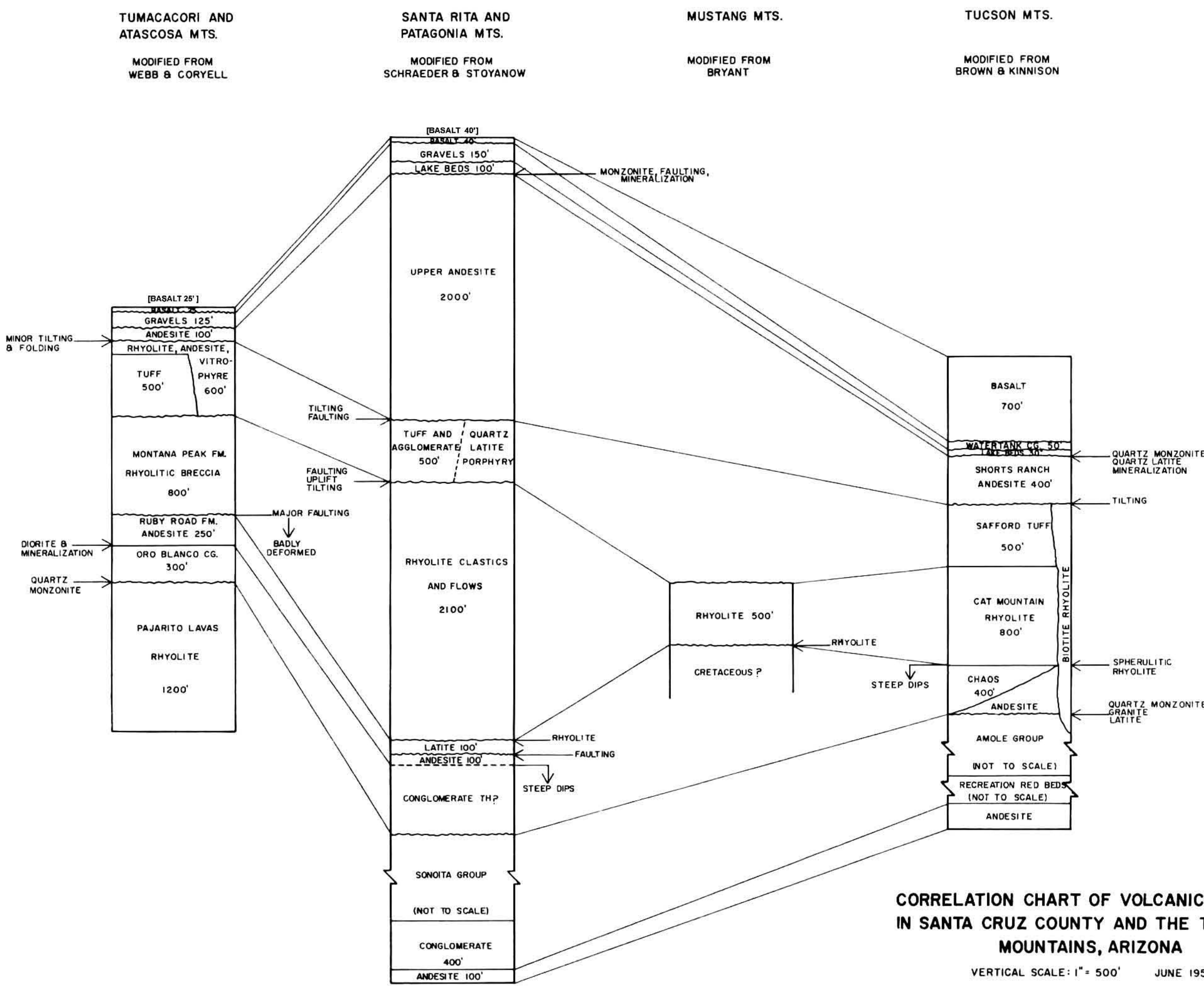

CORRELATION CHART OF VOLCANIC ROCKS IN SANTA CRUZ COUNTY AND THE TUCSON MOUNTAINS, ARIZONA

VERTICAL SCALE: 1" = 500'   JUNE 1959

COMPILED BY O. J. TAYLOR

TABLE 1.-ALPHA COUNT, POTASSIUM CONTENT, AND EMISSION SPECTROGRAPH DATA OF VOLCANIC UNITS.

Sample	ALPHAS/mg/hr	%sd	%K	%sd	Cr	Cu	Mg	Ca
Atascosa Mts. basalt 1 Bottom	0.559	7.86	1.04[1]	7.10	28	40	62	64
Atascosa Mts. basalt 2 Bottom	0.558	7.99	0.963	6.46				
Atascosa Mts. basalt 3 Bottom	0.668	7.40	1.11	6.40				
Atascosa Mts. basalt 1 Top	0.530	8.36	1.00	6.28				
Atascosa Mts. basalt 2 Top	0.633	7.76	1.07	4.99				
Atascosa Mts. basalt 3 Top	0.547	8.38	0.917	6.63				
Santa Rita Mts. basalt	1.05	6.75	1.66	5.53	48	44	72	63
Tucson Mts. basalt Composite	2.18	5.74	2.85	3.52	13	37	46	52
Tucson Mts. basalt Top	1.97	6.50	3.22	3.03	27	38	64	67
Atascosa Mts. upper andesite	3.29	5.64	3.68	4.98	00	35	66	70
Sycamore andesite	4.88	6.24	3.87	4.46	00	36	45	46
Santa Rita Mts. upper andesite	2.00	5.88	2.54	4.74	00	41	66	64
Short's Ranch andesite	1.34	6.07	3.26	5.02	00	37	57	60
Sycamore spherulitic rhyolite	7.40	5.77	4.32	5.80	00	12	45	50
Quartz latite porphyry	3.57	5.60	3.91	4.48	00	21	49	52
Biotite rhyolite	2.22	6.36	3.89	2.76	00	18	49	56
Atascosa Mts. tuff	4.64	6.32	4.64	5.42	00	24	56	55
Santa Rita Mts. tuff	2.90	6.41	3.90	5.35	00	32	60	59
Safford tuff	2.76	6.50	2.84	6.13	00	34	61	64
Montana Pk. fm. 1 Bottom	2.02	6.35	2.92	4.94				
Montana Pk. fm. 2 Bottom	1.70	6.34	2.00	4.02				
Montana Pk. fm. 3 Bottom	1.31	6.19	2.40	5.94				
Montana Pk. fm. 1 Top	1.58	6.70	2.77	5.06				
Montana Pk. fm. 2 Top	7.06	6.20	5.14	5.92	00	26	42	41
Montana Pk. fm. 3 Top	2.92	6.08	2.01	6.45				
Santa Rita Mts. rhyolite	3.66	6.10	2.97	3.65	00	35	56	52
Mustang Mts. rhyolite	2.66	6.50	8.02	1.78	00	10	53	51
Cat Mountain rhyolite	2.33	5.65	4.24[2]	5.07	00	22	54	51
Ruby Road fm.	1.52	6.64	3.12	4.31	00	32	57	58
Santa Rita Mts. older andesite	1.55	6.19	2.62	3.26	00	28	48	44
Santa Rita Mts. older latite	1.81	6.68	5.68	1.81	00	10	66	67
Tucson Mts. older andesite	1.52	6.56	3.43	4.24	00	37	57	66
Pajarito lavas	3.84	6.38	4.84	3.27	00	05	50	57
Santa Rita Mts. Cret. andesite	1.59	6.54	2.62	6.14	00	45	69	79
Tucson Mts. Cret. andesite	1.09	7.19	3.29	3.58	00	13	61	73
Columbia River basalt	0.4916	?	1.07	5.94	10	48	80	82

1. 0.98% by flame photometry
2. 4.41% by flame photometry

accepted. In the Precambrian of Arizona there was notable orogeny and volcanic activity. In the Paleozoic, structural deformation is negligible and volcanic activity is unknown. Again, in the Mesozoic and Cenozoic, deformation and volcanic activity occurred and are undoubtedly related.

Structural deformation appears to both precede and continue concurrently with volcanism. Thus in the area under study, the Cretaceous volcanic rocks were preceded by structural uplift in Southern Arizona in early Mesozoic time. The thick tertiary sequence was preceded by Laramide deformation. The thin Quaternary volcanic rocks were preceded by Tertiary deformation which was mainly tilting. This explains the above-mentioned occurrence of volcanism as related to structural deformation. Also, the periods of extreme deformation are followed by extreme volcanism while periods of minor deformation are followed by minor volcanism.

Each volcanic unit was sampled for the purpose of making chemical tests for attempted correlation. Each sample was ground to -65 mesh, washed in distilled water, and dried. The alpha activity was determined on a low level scintillation alpha detector. The alpha activity figures shown on Table 1 are proportional to the U and Th content of the rock. Separate U and Th analyses were not made. The accuracy of the method is shown by the per cent standard deviation, the error encountered in counting methods.

The potassium content of each rock was estimated by measuring the beta activity of each sample on a low level anti-coincidence beta counter. These potassium analyses were verified by running two samples on a flame photometer and the percentages obtained check within the standard deviation of the per cent potassium computed by counting methods.

Each sample was also arced in an emission spectrograph and analyzed for Cr, Cu, Mg, and Ca. The data obtained are not percentages but readings on a photometric density scale which have been multiplied by 100. These figures are at best semi-quantitative but still proportional to the amount of the element present.

Intraformation studies were made on the basalt from the Atascosa Mountains and a rhyolitic breccia, the Montana Peak formation, from the same range. The basalt is more uniform than the breccia as would be expected. The most recent basalt flow from the Tucson Mountains is more mafic than the composite sample of basalts from these mountains.

The olivine basalts vary greatly in alpha activity and potassium content. Basalts from the Santa Rita and Tucson Mountains have very high potassium contents as well as alpha activities. All these basalts contain quartz as previously mentioned. These basalts must have been affected by syntexis must have occurred just prior to solidification, otherwise the olivine would have reacted with the silica to form pyroxene.

Possible geochemical correlations which became evident from this study are: the basalts all have similar Cu contents; the upper andesites also have similar Cu contents; in the rhyolite and latite group, two of the units have similar K, Cu, and Mg contents; two of the tuffs have similar alpha activities Mg, and Cu contents; the rhyolites have similar Mg and Ca contents except for one more felsic rhyolite; the older andesites have almost identical alpha activities, while the Cretaceous(?) andesites have very few similarities.

A review of the literature indicates that this recurring sequence of volcanic rocks is widespread in southern Arizona, southwestern New Mexico, and northern Sonora, Mexico.

The kind of chemical studies undertaken in this work may be of great value in volcanic petrography. Because of the glassy or aphanitic nature of most volcanics, the minerals which may be identified in hand specimen or thin section frequently represent only a small portion of the total mass of the rock. Consequently, without chemical analysis very diverse rock compositions may be classified in the same category and, vice versa, rocks of identical composition may be classified in different categories, for example, a porphyritic volcanic may be classified as an andesite, whereas, a non-porphyritic facies of the same magma may be classified as a basalt. This difficulty can lead to a failure in correlation. Thus, combined petrographic and quantitative chemical work of even limited extent on porphyries and aphanites is a distinct aid to correlation.

The origin of these volcanic sequences can be related either to mobilization of existing rock in the crust and mantle or to magmatic differentiation. Since extremely large parent magmas would be required to supply such large quantities of siliceous volcanic rock by differentiation, the former seems more likely. On the other hand, the great similarity of the Tertiary sequences suggests that they may have been derived from one parent magma or similar parent magmas perhaps formed by fractional fusion. The magmas must have been siliceous in composition in order to account for the great thickness of felsic rocks.

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