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A Summary of Radiometric Ages of Igneous Rocks in the Oquirrh Mountains, North-Central Utah *

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Abstract

On the basis of seven new and five previously published K-Ar age determinations, the apparent overall duration of magmatism in the Oquirrh Mountains was about 8 m.y. (38.6 to 30.7 m.y.). The periods of plutonism and volcanism overlapped in time. The larger monzonitic stocks and older units of the latitic volcanic sequence have ages ranging from 39 m.y. to 36 m.y.; rocks of rhyolitic composition, with ages ranging from 33 m.y. to 31 m.y., are probably the slightly younger differentiates of a larger monozonitic parent mass inferred from magnetic data to underlie the Oquirrh Mountains. The ore bodies associated with rhyolitic rocks at Ophir and Mercur may be 4 to 5 m.y. younger than those associated with monzonitic rocks at Bingham and Stockton.

Geology

THE emplacement of igneous rocks exposed in the Oquirrh Mountains is related to structural features of both regional and local extent. The intrusive centers at Bingham and Stockton are near the crest of a broad magnetic high (Fig. 1) that extends over 30 miles westward from the Clayton Peak stock, which is about 5 miles west of the Park City district in the Wasatch Range (see Mabey et al., 1964). Crittenden and Kistler (1966) have previously reported Oligocene ages for the Clayton Peak, Alta, and Little Cottonwood stocks. These data are consistent with the evidence summarized by Tooker (1971) that intrusive rocks in north-central Utah were emplaced over a relatively short period of time along an east–west zone of uplift that coincides with the Cortez-Uinta axis of Roberts et al. (1965). The various intrusive centers, indicated by local magnetic relief on the regional high, may represent cupolalike extensions from an igneous mass of batholithic proportions and thus may be continuous at depth, as noted by Mabey et al. (1964). Two-dimensional computer modeling of the magnetic data by John Cady, Stanford University, provides permissive support for this interpretation. According to Cady (oral commun., 1972), a model intrusive body that closely duplicates the magnetic anomaly over the Last Chance stock in the Bingham district has an outcrop width of about 1 mile and approximately vertical walls from the surface to a depth of 3 to 5 miles; at this level the stocklike intrusion connects with a larger body that widens with depth.

The distribution of individual plutons in the Oquirrh Mountains suggests localization by structural features resulting from the deformation of Paleozoic sedimentary rocks in the upper plate of the Midas thrust (Fig. 1). With several minor exceptions, the igneous rocks were emplaced within zones of structural weakness along the axes or in the oversteepened eastern limbs of folds that originated during northeastward thrust movement in Late Cretaceous and early Tertiary time (Tooker, 1971). This relation is best seen in the northwesterly alignment of intrusive bodies between Mercur and Stockton; it is further emphasized by the northwest trend of magnetic anomalies near Stockton (Fig. 1; Moore et al., 1966, fig. 2), suggesting the presence of a larger buried intrusive mass having its axis of elongation generally parallel to major folds in this area.

Similarly, the magnetic data suggest that the Bingham district a short distance to the northeast is underlain by a buried west-northwest-trending intrusive mass. Although the emplacement of the Last Chance and Bingham stocks (locs. 1 and 2, respectively, on Fig. 1) cannot be related simply to major fold axes, several lines of evidence do suggest that a zone of structural weakness that locally guided the emplacement of small intrusive bodies may extend to the southeast for at least 10 miles. Recent mapping (Moore, unpublished data) indicates the presence of a sharply overturned, northwest-trending anticlinal fold in the east-central part of the map area shown in Figure 1; rhyolite flows in the vicinity of location 11 are intruded by small latite dikes along the projected axial zone of this fold. In addition, a general northwestern alignment of intermediate and silicic plugs extends from this area toward Bingham (cf., Gilluly, 1932).

The proximity of intrusive and extrusive rocks of the eastern Oquirrh Mountains and similarities in

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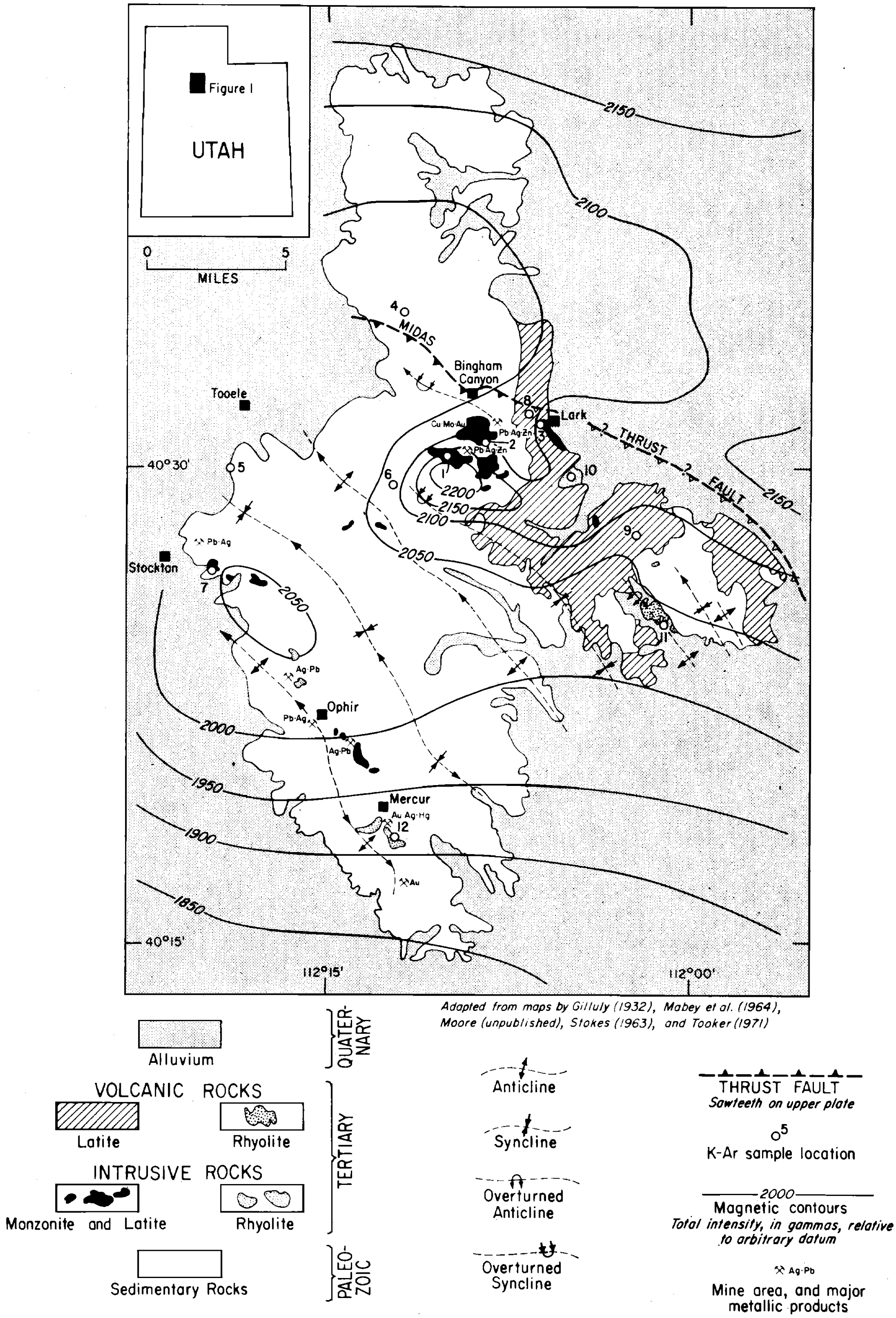

FIG. 1. Geologic sketch map of Oquirrh Mountains showing K-Ar sample locations and aeromagnetic contours.

TABLE 1. Radiometric Ages of Igneous Rocks in the Oquirrh Mountains

Sample Number[1] and Location	Rock Unit	K_2O (percent)	Ar_{rad}^{40} (10^{-10} moles/gm)	Ar_{rad}^{40} / Ar_{total}^{40}	Apparent[2] Age (m.y.)
1: Bingham district; 40°30′24″N., 112°10′12″W.	Last Chance stock[3,4] (augite-biotite monzonite)	—	—	—	38.6 ± 0.18
2: Bingham district; 40°31′24″N., 112°08′24″W.	Margin of Bingham stock[3,4] (augite-monzonite and hornblende-biotite quartz monzonite)	—	—	—	37.6 ± 0.07
3: Bingham district; 40°31′24″N., 112°06′24″W.	Quartz latite porphyry dike[3]	—	—	—	36.9 ± 1.0
4: Pass Canyon area; 40°35′00″N., 112°12′00″W.	Latite porphyry dike	9.09	4.93	0.76	36.5 ± 1.1
5: Selkirk Canyon area; 40°30′00″N., 112°19′00″W.	Quartz monzonite porphyry sill[5]	8.68	4.99	0.80	38.6 ± 1.1
6: Middle Canyon area; 40°29′36″N., 112°12′24″W.	Quartz latite porphyry dike[5]	8.97	4.94	0.80	37.1 ± 1.1
7: Stockton district, Calumet mine area; 40°26′48″N., 112°19′48″W.	Monzonite porphyry stock[5]	8.44	2.41	0.89	38.0 ± 1.1
8: Bingham district; 40°31′40″N., 112°06′30″W.	"Andesite porphyry" flow[6]	5.22	3.02	0.44	38.8 ± 0.9
9: South Mountain; 40°28′00″N., 112°02′24″W.	Hornblende latite tuff-breccia[7]	8.34	3.81	0.67	30.7 ± 0.9
10: Dry Canyon area; 40°29′48″N., 112°05′00″W.	Shaggy Peak plug[3,5] (Biotite rhyolite vitrophyre)	—	—	—	33.0 ± 1.0
11: Tickville Gulch; 40°25′12″N., 112°01′12″W.	Tickville rhyolite flow[5,7] (Biotite rhyolite vitrophyre)	8.06	3.74	0.58	31.2 ± 0.9
12: Mercur district, Sacramento mine area; 40°18′24″N., 112°12′12″W.	Eagle Hill rhyolite plug[5] (fine-grained biotite rhyolite)	8.69	4.09	0.79	31.6 ± 0.9

[1] From figure 1.
[2] Plus-or-minus values for first two ages are pooled estimates of precision based on replicate measurements; for the remaining ages plus-or-minus values are estimated standard deviations of analytical precision taken to be about ±3 percent.
[3] Moore and others, 1968 (analytical data).
[4] Moore and Lanphere, 1971 (analytical data).
[5] Gilluly, 1932 (field relations and petrographic descriptions).
[6] Armstrong, 1970 (analytical data).
[7] Moore, 1972 (field relations and petrographic descriptions).

composition between the monzonitic plutons and latitic extrusive rocks (Gilluly, 1932; Moore, 1972) suggest that they are related phases of a single magmatic episode. Periodic venting of some of the shallow intrusives in the Bingham area apparently fed the flows; conversely, latite dikes intruded the flows at various times during the magmatic episode.

Radiometric Ages

All of the ages reported here were determined by the K-Ar method on biotite separated from unaltered rocks. Sample locations shown on Figure 1 are listed in Table 1, together with rock descriptions and analytical data. The analyses (excluding no. 8) were made in the Denver and Menlo Park laboratories of the U. S. Geological Survey by R. W. Kistler, M. A. Lanphere, J. D. Obradovich, and J. C. Von Essen. On the basis of previous studies summarized by Moore and Lanphere (1971), the oldest pluton in the Bingham district is the Last Chance stock (loc. 1, Fig. 1); it is composed of augite-biotite monzonite with an age of 38.6 m.y. (average of three ages from different locations in the stock). Unaltered monzonitic rocks at the southeast margin of the Bingham stock (loc. 2, Fig. 1) have an age of 37.6 m.y. (average of three ages). Both stocks and volcanic rocks east of the district are intruded by latitic dikes with ages ranging from 37.4 m.y. (Moore and Lanphere, 1971) to 36.9 m.y. (loc. 3, Fig. 1).

Three minor intrusions of intermediate composition from widely separated areas west of the Bingham district give ages ranging from 38.6 m.y. to 36.5 m.y. (locs. 4–6, Fig. 1) and are similar in age to the Bingham igneous complex. The small monzonitic stock near the Calumet mine in the Stockton district (loc. 7, Fig. 1) is also apparently contemporaneous. This stock predates mineralization, and its age of 38.0 m.y. places an upper limit on the age of ore deposition.

The volcanic rocks in the Oquirrh Mountains are largely confined to an area extending east and south of the Bingham district (Fig. 1). Armstrong (1970) reports an age of 38.8 m.y. for an "andesite porphyry" flow west of the Lark townsite (loc. 8, Fig. 1). This flow, which is probably near the base of the volcanic sequence, is indistinguishable in age from the Last Chance stock. Note also that a minimum age of 36.9 m.y. is indicated for flows cut by the quartz latite porphyry dike at location 3 on Figure 1; however, a latitic tuff-breccia in the uppermost part of the preserved volcanic section (loc. 9, Fig. 1) gives an age of 30.7 m.y.

Latitic flows east of the Bingham district are intruded by the Shaggy Peak volcanic plug (loc. 10, Fig. 1), a glassy rhyolite with an age of 33.0 m.y. A rhyolite vitrophyre flow exposed in Tickville Gulch about 6 miles southeast of Shaggy Peak gives an age of 31.2 m.y. (loc. 11, Fig. 1). The 31.6 m.y. age of intrusive Eagle Hill rhyolite exposed in the Mercur district (loc. 12, Fig. 1) agrees closely with the ages of other rhyolite bodies in the Oquirrh Mountains.

Discussion

Although the apparent duration of magmatism was less than 8 m.y., the igneous rocks of the Oquirrh Mountains may be conveniently subdivided into two groups, both of Oligocene age. Intrusive rocks of intermediate (monzonitic-latitic) composition and flows in the lower part of the volcanic sequence yield ages ranging from 39 m.y. to 36 m.y. In contrast, the silicic igneous rocks of both intrusive and extrusive origin and latitic extrusive rocks in the upper part of the volcanic sequence yield ages ranging from 33 m.y. to 31 m.y.

These results suggest that plutonism and volcanism in the Bingham district were broadly contemporaneous. No volcanic rocks have been dated that are significantly older than the monzonitic plutons at Bingham, and thus Gilluly's (1932, 1969) conclusion that the extrusive rocks as a whole antedate the intrusives cannot be confirmed. However, terminal latitic volcanism, as represented by the 30.7 m.y. tuff-breccia capping South Mountain (loc. 9, Fig. 1), clearly postdated emplacement of the monzonites, and Boutwell's (1905) conclusion that the volcanic rocks are generally younger is in part substantiated. The available evidence indicates that plutonism and volcanism in the Oquirrh Mountains overlapped in time.

A more direct generalization concerns the chemical evolution of the igneous rocks with time. Whereas the intrusive and extrusive rocks included in the older (39 m.y.–36 m.y.) Oligocene age group are monzonitic or latitic in composition, all rhyolitic rocks fall in the younger (33 m.y.–31 m.y.) age group. This time-progression is attributed to the differentiation of the larger monzonitic parent mass inferred from magnetic data to underlie the central Oquirrh Mountains.

The twofold grouping of radiometric ages also suggests two distinct periods of ore mineralization in the Oquirrh Mountains if, as at Bingham (cf., Moore and Lanphere, 1971), the mineralization at Stockton, Ophir, and Mercur closely followed the crystallization of spatially associated intrusive rocks. Evidence for a progressive change in the character of the ore deposits with increasing distance from the Bingham district was first summarized by Butler et al. (1920) and is complemented by these results: the ores associated with near-surface rhyolitic intrusive rocks at Mercur (Au-Ag-Hg) and Ophir (Pb-Ag) are apparently 4 to 5 m.y. younger than those associated with more deep-seated monzonitic intrusions at Stockton (Pb-Ag) and Bingham (Cu-Mo-Pb-Zn-Ag-Au).

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