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ABSTRACT

The mineral resource potential of the buried Precambrian basement in the Harrison Quadrangle is appraised on the basis of only six drill holes that bottom in igneous rock, and from U.S. Geological Survey aeromagnetic and gravity maps. The western third of the quadrangle, as shown by the six drillholes and by magnetic anomaly patterns characteristic of granite-rhyolite terranes, is underlain by epizonal granite and rhyolite correlated with the 1.34 to 1.40 Ga Spavinaw terrane, one of the major Middle Proterozoic anorogenic granite-rhyolite provinces in the U.S. midcontinent. The eastern two-thirds of the quadrangle is inferred to be underlain by metamorphic rocks of the Early Proterozoic Central Plains orogen, and the 1.45 to 1.48 Ga St. Francois terrane, another of the major anorogenic granite-rhyolite terranes.

The Central Plains and St. Francois terranes are inferred to extend south and southwest from the adjoining Springfield and Rolla Quadrangles, where they have been confirmed by drillholes and outcrops.

By analogy with mineralization types known in the St. Francois terrane, 10 areas are designated in the Harrison Quadrangle for potential ore deposits. Both the St. Francois and Spavinaw terranes are generally considered to be favorable for complex iron-copper-uranium-gold-rare-earths (Olympic Dam-type) mineralization. As any potential and hypothetical deposit in the Harrison Quadrangle is covered by 1000 to 3000 ft of sedimentary rock, exploratory drilling should be based on geophysical anomalies and lineament studies.

INTRODUCTION

This report is part of the Harrison 2-degree Conterminous United States Mineral Appraisal Program (CUSMAP), a cooperative study between the U.S. Geological Survey and the State Geological Surveys of Missouri and Arkansas.

In the Harrison 2-degree Quadrangle very few deep holes extend to the Precambrian basement. In the Missouri part of the quadrangle, there is one core hole and two older holes from which only cuttings are available; in the Arkansas part of the quadrangle, there is one core hole and two holes with cuttings only. Because of the sparse data, the Precambrian basement map for the Harrison sheet was drawn at 1:500,000 scale (Kisvarsanyi, 1988).

DESCRIPTION OF ROCKS

Missouri

The three holes in the Missouri part of the quadrangle are B-1, B-2 (in Barry County), and Ta-1 (in Taney County) (fig. 1).

B-1 is the City of Monett's #2 water well, drilled in 1916; only cuttings are available from this hole. The bottom sample, 1908 ft from the surface, shows red granophytic granite assigned to the Spavinaw rock association from its mineralogical similarity and nearness to known Spavinaw Granite outcrops and subcrops. Some epidote, chlorite, and pyrite were also noted in the sample.

B-2 is the Barry County Oil and Gas Company's #1 Jenkins well, drilled in 1922. This well penetrated 194 ft of Precambrian rock identified as a sequence of rhyolite, tuff, and andesite or trachyte. The rocks are extensively altered (epidote, chlorite, sericite) and possibly slightly metamorphosed; some fine sericite-phylite samples are among the cuttings. Quartz and calcite microinlets were also observed in the samples. This section of volcanic rocks is possibly related to Denison's "Washington County Volcanic Group" (named from Oklahoma), which has a rather extensive subsurface distribution in the Tri-State area (Denison, 1966). These volcanics are assumed to be related to the Spavinaw epizonal terrane, which is inferred to underlie much of southwestern Missouri.
Ta-1 is the St. Joe Lead Company's 64W58 hole, a mineral exploration core that penetrates 10 ft of granite at the bottom. The granite is medium- to coarse-grained, porphyritic, and mafic-rich. It has large (up to 1 inch) insets of microcline-perthite in a hypidiomorphic fabric of orthoclase-perthite and quartz. The mafic mineral is euhedral amphibole, but biotite is also present. Accessory minerals include apatite, zircon, fluorite, and magnetite. The rock, classified as an amphibole-biotite-alkali feldspar granite, is probably related to the Spavinaw rock association, but its age is undetermined.

All three of these drillholes are in the western half of the Harrison Quadrangle.

Arkansas
The three holes in the Arkansas part of the quadrangle are Ca-1 (in Carroll County), and Md-1 and Md-4 (in Madison County). The description of the rocks is given from Denison (1984).

Ca-1 is the St. Joe Lead Company's hole, a mineral exploration hole that cut 21 ft of red micrographic granite porphyry characteristic of the Spavinaw rock association. Phenocrysts of plagioclase, some quite large, are rimmed by perthite and are set in a generally micrographic quartz-feldspar matrix. The perthite is dusted with extensive, uniformly spaced hematite and vacuoles. Plagioclase is calcic oligoclase and contains locally intense sericite-epidote-clay alterations. The amphibole, in clots with other accessories, occurs as a common pale green variety and as actinolite; chlorite is associated with these clots. A reddish variety of sphene occurs as anhedral crystals. Numerous small crystals of apatite and zircon are present. Grain size: phenocrysts, 7+ mm; groundmass 1.0-1.8 mm. The rock has a porphyritic-micrographic texture. Carbonate is conspicuous as veins and as a replacement of a former femic mineral. The general texture and mineralogic abundances are typical of all epizonal granites in northwest Arkansas.

Md-1, Independent Oil Company's No. 1 Banks test hole drilled in 1929, penetrated a few feet of rhyolite porphyry. Phenocrysts of altered plagioclase and sparse perthite are in a quartz-feldspar groundmass. The texture of the groundmass is not well defined; parts appear to have optically oriented rod-like quartz. Feldspars are altered and contain hematite dust. Plagioclase contains sericite flakes and epidote granules. Chlorite masses replace portions of some feldspar phenocyrts and is also in the groundmass as probable pseudomorphs after a femic mineral and as disseminated shreds. The iron oxide granules are partly surrounded by sphene-leucoxene. Grain size: phenocrysts, 2 mm; groundmass, 0.2 mm. Texture: porphyritic-felted. The rock is classified as part of the Spavinaw terrane.

Md-4, the Layne Western No. 1 Huntsville test hole drilled in 1981, penetrated 5 feet of metarhyolite porphyry. Phenocrysts of feldspar and smaller phenocrysts quartz are in a finely granoblastic groundmass of the same minerals. The largest cutting chip is about 1.5 mm long. Hematite dust and vacuoles cloud feldspars, obscuring the composition. Chlorite replaces former femic minerals and occurs as fine shreds in the groundmass, which is almost entirely a granoblastic quartz-feldspar mosaic. Grain size: phenocrysts, 1.3+ mm; groundmass, 0.03 mm. Texture: relict porphyritic-granoblastic. Metamorphism of rhyolite in this well is unusual and suggests a nearby pluton.

**PRECAMBRIAN STRUCTURE**

The Chesapeake and Bolivar-Mansfield tectonic zones (Kisvarsanyi, 1984) are projected to trend southeastward across the quadrangle(fig. 1). The eastern flank of the Spavinaw arch, a Precambrian high underlying the Tri-State district (Denison, 1966), dominates western part of the quadrangle. The Precambrian surfaces slopes and deepens to the east and south, and may be down-faulted along the Chesapeake tectonic zone. Regional contour lines on the Precambrian surface, projected from drillholes outside of the Harrison Quadrangle, suggest a deep embayment, graben, or trough between the Chesapeake and Bolivar-Mansfield tectonic zones; this inferred embayment appears to widen south-eastward, toward the Mississippi embayment.
BASEMENT TERRANES

The six basement holes in the Harrison Quadrangle are in its western half; with the exception of Ta-1, all are in rhyolites and epizonal granites probably correlative with the Spavinaw terrane (1.34-1.40 Ga), which underlies extensive regions in southwest Missouri, northwest Arkansas, northeast Oklahoma, and southeast Kansas (Thomas et al., 1984). Ta-1 represents a mesozonal mafic-rich granite similar to granites associated with ring intrusions in the St. Francois terrane (Kisvarsanyi, 1981). It too is correlated with the Spavinaw terrane, because the associated magnetic pattern is similar to that farther west, where rhyolites and granophyres occur (fig. 1).

Between the Chesapeake and Bolivar-Mansfield tectonic zones it is assumed that the basement comprises rocks of the Early Proterozoic Central Plains orogen (Sims and Peterman, 1986). The orogen is inferred to extend into the Harrison Quadrangle from the northwest, where it is documented by drillholes in the Springfield Quadrangle (Kisvarsanyi, 1985).

An odd-shaped area of magnetic highs in the southeastern part of the quadrangle is provisionally assigned to the 1.45-1.48 Ga St. Francois terrane, which comprises epizonal granites and associated rhyolites identified in the Rolla Quadrangle (Kisvarsanyi, 1981), from the areal magnetic pattern (McCafferty et al., in preparation). The northeastern corner of the quadrangle, north of the projection of the Bolivar-Mansfield tectonic zone, is also inferred to be underlain by rocks of the St. Francois terrane, an assumption based on projections from the neighboring Springfield and Rolla Quadrangles.

MINERAL RESOURCE POTENTIAL

No metallic mineral resources are known in the Precambrian rocks in the Harrison Quadrangle; however, the two Middle Proterozoic epizonal terranes, the Spavinaw and the St. Francois, are both generally favorable for the occurrence of metallic minerals. Petrographic, geochemical, and tectonic analogies suggest that the Spavinaw and St. Francois terranes could have similar metallogenesis, and that the same types of mineral deposits could be expected in both. The most important of the possible mineralization types is a class of Proterozoic iron-oxide-rich deposits that often occur with rare earths (RE) and other metals (Cu, U, Au, Ag), and is referred to as "Olympic Dam-type" after the giant Olympic Dam deposit in South Australia (Roberts and Hudson, 1983). Worldwide, these deposits typically occur in anorogenic granite-rhyolite terranes, are associated with magnetic and gravity anomalies, and can be targets for exploration in buried terranes. In southeastern Missouri, more than two dozen magnetite-apatite-hematite deposits occur in the St. Francois terrane, some with associated RE and Cu-Au mineralization.

Sims et al. (1987), in a discussion of possible Olympic Dam-type deposits in the U.S. midcontinent, elaborated on a favorable terrane of clastic rocks in a graben defined by the Chesapeake and Bolivar-Mansfield tectonic zones (fig. 2), because early accounts of the Olympic Dam deposit described its host rocks as a sequence of sedimentary breccias (Roberts and Hudson, 1983). In view of the evolving Olympic Dam model concepts (Oreskes, oral communication, 1988), it may be unnecessary to restrict the host rocks for Olympic Dam-type deposits to sedimentary breccias. Positive identification of rhyolite and granite breccias, high magnetic anomalies, coincident gravity anomalies, and long linear structures are considered to be favorable diagnostic criteria.

In view of the above criteria, 10 areas are outlined in figure 2 as generally favorable for complex Olympic Dam-type deposits. Area No. 1 is the most favorable because of a coincident magnetic and gravity high, a situation reported from the Olympic Dam deposit (Roberts and Hudson, 1983); however, the St. Francois terrane is only inferred here. Areas 2, 3, 4, and 5 are less favorable, because only magnetic highs are associated with them; there are no coincident gravity highs.
Areas 6 and 8 are favorable because of magnetic highs and positive (drillhole) identification of the Spavinaw terrane. Area 9 is defined by a magnetic high in inferred St. Francois terrane rocks. Area 10 marks a magnetic high outside the graben and inferred Early Proterozoic rocks. Drillhole H-67 (fig. 2), however, bottomed in exceptionally thick, coarse clastics, and may therefore mark an area of moderately favorable ground for mineralization.

Fig. 1. Precambrian basement map of the Harrison Quadrangle, Missouri and Arkansas.

Explanation

Yspg
Spavinaw granite

Yspr
Spavinaw rhyolite

Ysf
St. Francois terrane

Xm
Metamorphic terrane

Inferred contact

Inferred tectonic zone

Structure contour

Drill hole to basement

Drill hole in sediment
Fig. 2. Areas of potential Olympic Dam-type mineralization in the Harrison Quadrangle, Missouri and Arkansas.

Explanation

Yspg  Spavinaw granite
Yspr  Spavinaw rhyolite
Ysf   St. Francois terrane
Xm    Metamorphic terrane
       Inferred contact
       Inferred tectonic zone
       Structure contour
       Drill hole to basement
       Drill hole in sediment
       Area of potential Olympic Dam-type mineralization
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