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GEOLOGICAL SURVEY CIRCULAR 869

Mineral-Resource Appraisal of the Rolla 1° × 2° Quadrangle, Missouri, As of September 1980— A Nontechnical Summary

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INTRODUCTION

For several years the U.S. Geological Survey has been conducting research on methods of mineral-resource appraisal for large rectangular map areas or quadrangles measuring 1 degree (69 miles) north-south and 2 degrees east-west (90-120 miles, depending on the latitude). One such area that has been under study is the Rolla 1°×2° quadrangle, southeast Missouri (fig. 1). The Rolla quadrangle was selected for this purpose because it includes most of the Southeast Missouri lead mining district and parts of the barite and iron-ore mining areas. In recent years Missouri has ranked first among the 50 States in mine production of lead (used principally in automobile batteries and gasoline additives), second in zinc (used to galvanize iron and in several alloys), second in barite (used in drilling muds for oil and gas wells), and sixth in silver (used in the photographic and electronic industries as well as for sterling and plateware). Nearly all this mineral production came from the Rolla quadrangle, which still contains the largest known lead reserves in the world plus important resources of zinc, barite, silver, copper, iron, and the strategic ferrous metals nickel and cobalt.

The important base-metal ores of the Southeast Missouri district occur in geologic formations that extend in the subsurface for hundreds of miles north, west, and northeast through the midcontinental United States; hence it was reasoned that the Rolla quadrangle should serve as a testing ground for appraisal methods that might later be used throughout the midcontinent region, and in other regions where similar geologic environments suggest a potential for similar kinds of mineral deposits.

The mineral-resource study of the Rolla quadrangle was a cooperative project of the U.S. Geological Survey and the Missouri Division of Geology and Land Survey. The project involved about 19 professional man-years of effort, contributed by 24 geologists and other scientists of both organizations during the period 1975–1980. The full mineral-resource appraisal of the Rolla quadrangle, including all the technical data and interpretations, has been released as U.S. Geological Survey Open-File Report 81–518 (see reference at end of paper). This Circular is a nontechnical summary of the methodology and results of the appraisal, written mainly for non-geologists.

The date of September 1980 is an essential part of the title of the Rolla mineral-resource appraisal. A mineral resource is defined as a natural concentration of elements in such form that a usable commodity can be extracted from it. Critical factors in the appraisal of a potential resource are its economic viability—whether or not it can be extracted at a profit— and the certainty of its existence. With changes in economic and legal conditions, development of new technologies of mining and mineral processing, improved understanding and theories of ore genesis, more detailed knowledge of the geology of the area, and development of new prospecting methods, an undeveloped or undiscovered mineral deposit may become a resource almost overnight. Thus any appraisal of resource potential is time-dependent, being based on economic and legal conditions, scientific and technologic knowledge, and data available, at a given

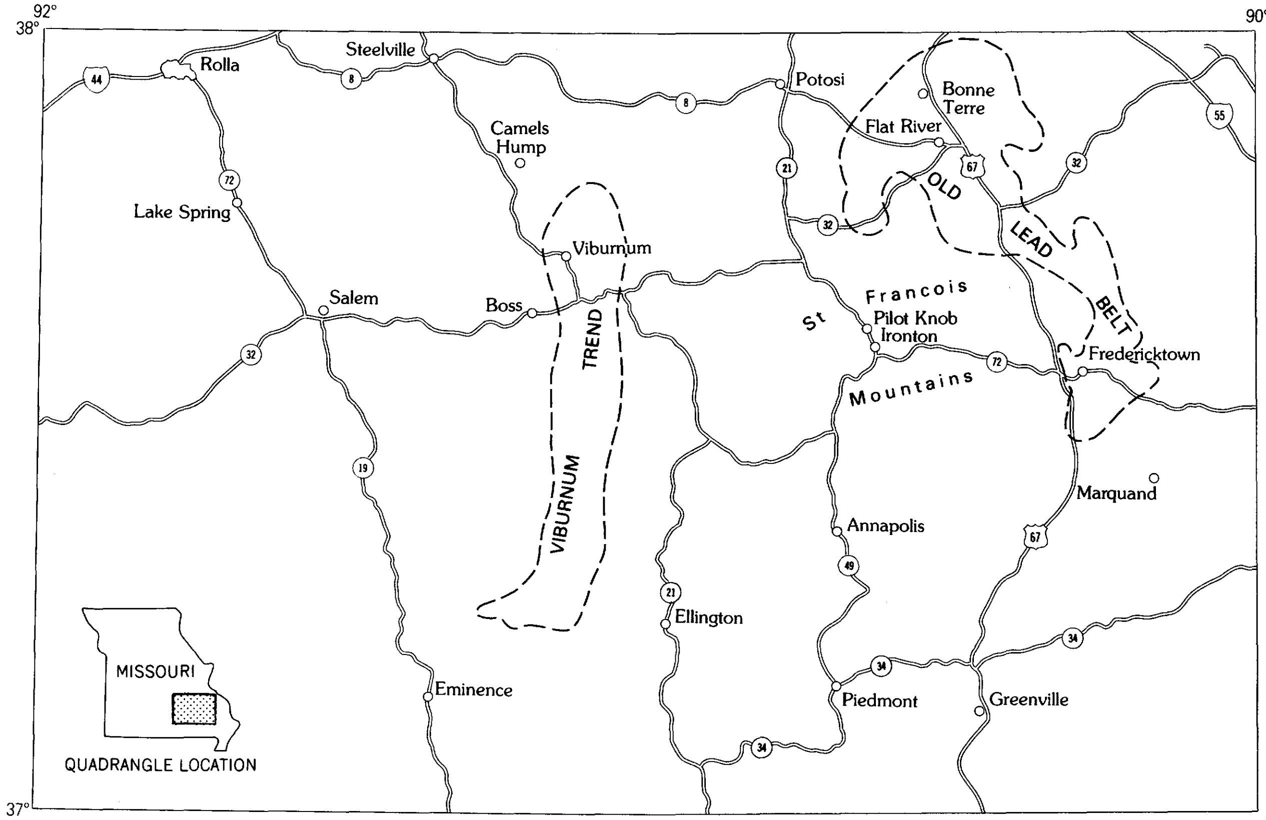

FIGURE 1. Rolla 1°×2° quadrangle, Missouri, showing principal towns, highways, and base-metal mining districts.

time. There is no such thing as a "final" appraisal of the resource potential of any area. Therefore it is emphasized that this report summarizes the resource potential of the Rolla quadrangle *as appraised in September 1980.*

METHODOLOGY

Prospectors have roamed the lower 48 States for generations, and most important mineral deposits that occur at the surface have long since been found. Therefore the task in appraising the resource potential of an area such as the Rolla 1°×2° quadrangle is to evaluate the likelihood that undiscovered mineral deposits of economic value may lie at depths of tens to thousands of feet beneath the surface. Many such deposits have already been found, through many years of painstaking and costly exploration programs conducted by the mining industry. The following questions are addressed by the resource appraisal of the Rolla quadrangle: is there a reasonable likelihood that other such deposits exist, and if so, how great is the probability, where are they, and what kinds of minerals do they contain?

Although no two mineral deposits are exactly alike, all deposits can be grouped according to the kinds of minerals they contain, the form in which they occur, and especially, the particular kinds of rocks and geologic structures they are associated with. Diamonds, for example, invariably are formed in a distinctive rock called kimberlite, and the informed prospector doesn't bother to look for diamonds unless he has good reason to think there is some kimberlite in the vicinity. Most other minerals are not so exclusive in their associations, but the fact remains that the world over, certain kinds of mineral deposits are associated with certain geologic environments, or critical combinations of rock type, age, and structure. This relationship is the principal basis for our resource appraisal of the Rolla quadrangle, and our method consists of six steps.

First, we compiled surface and subsurface maps, using surface observations, analyses of the mineral and chemical composition of outcrop and drill-hole samples, and geophysical maps showing the magnetic intensity and specific gravity of deeply buried "basement" rocks, to show the various geologic environments known or inferred to exist in the quadrangle. (In addition to compilation of existing data, this step required new reconnaissance geologic mapping of approximately 65 percent of the quadrangle, aeromagnetic surveying of the west half of the quadrangle, integration of data on rock composition from logs of some 1,000 drill holes, and spectrographic and chemical analyses of about 11,000 individual samples from 62 drill holes.)

Second, we determined all the types of mineral deposits that could reasonably be expected to occur in these geologic environments, on the basis of worldwide associations as well as known mineral occurrences in the Rolla quadrangle.

Third, we developed descriptive "models" of each deposit type—summary descriptions of the size, shape, tonnage, and mineral composition of a typical deposit, as well as the form, composition, structure, and any peculiar geological characteristics of the rocks the deposit is associated with. The models also include geochemical or geophysical "signatures" of the deposits that may be detected by chemical analysis of overlying or nearby rocks, or by surface or airborne measurements of the Earth's magnetic and gravity fields.

Fourth, from each model we derived sets of "recognition criteria"—distinctive geological, geochemical, or geophysical features that are so commonly associated with the deposits that they may be considered either essential or favorable for the occurrence of such deposits. (In the example given above, kimberlite is the principal essential recognition criterion for the occurrence of diamonds. There is no guarantee that every kimberlite body will contain diamonds, but we can safely assume that any diamonds to be found will be found in or close to kimberlites—or in gravels that have been eroded from kimberlites.)

Fifth, for each model, we systematically examined all the available data on the Rolla quad-

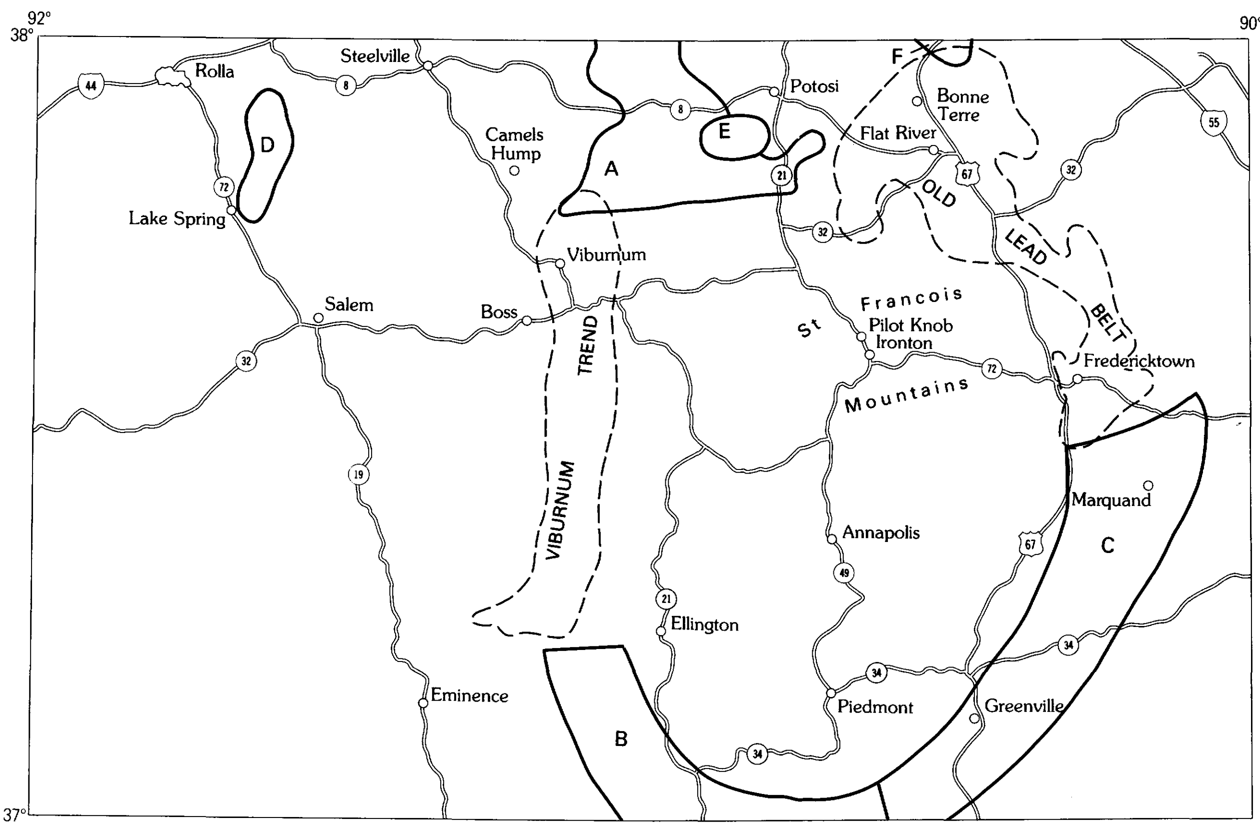

FIGURE 2. Areas of very high potential for base-metal deposits (A, B, and C) and for high-grade iron ores (D, E, and F) in the Rolla quadrangle.

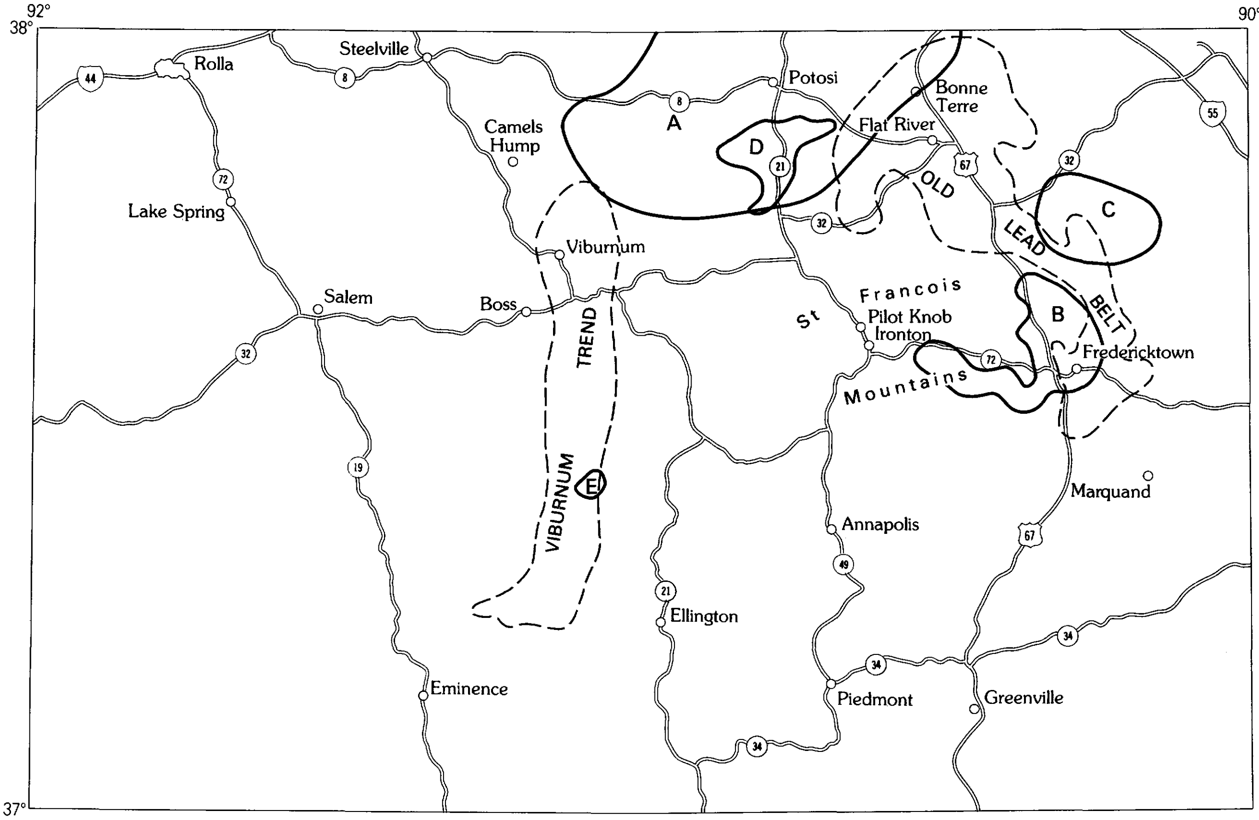

FIGURE 3. Areas of high potential for small barite deposits (A) and tin-tungsten veins (B), and areas that may have a potential for veins of rare-earth minerals and thorium (C, D, and E) in the Rolla quadrangle.

rangle, including much new data collected for this study, for the presence or absence of each of the recognition criteria.

Sixth, for each model, by plotting the areal distribution of the recognition criteria on a map of the quadrangle and evaluating their relative importance, we divided the quadrangle into areas in which various combinations of criteria indicate a high or low favorability for the occurrence of that type of deposit. In a few cases, our subjective evaluation has permitted us to rank favorable areas relative to each other.

RESOURCE POTENTIAL OF THE ROLLA QUADRANGLE

Applying the method just described, we considered the recognition criteria for 17 different types of mineral deposits that might reasonably be expected to occur in the Rolla quadrangle. Our principal conclusions were as follows:

A very high potential exists for two distinct types of deposits. The first of these is "base-metal" deposits—containing lead, zinc, and copper, as well as silver and the ferrous metals nickel and cobalt—like the deposits that were mined in the past in the Old Lead Belt and Fredericktown-Mine La Motte area and are currently being mined in the Viburnum Trend (see fig. 1). Three specific areas in the quadrangle contain such favorable combinations of the recognition criteria for this type of deposit that we believe there is a very high probability that each area contains at least one major deposit, at unknown depths ranging from 600 to 2,000 feet; these areas are in Washington County north of county highway C (fig. 2, area A), southeast from about 8 miles west of Ellington to the southern boundary of the quadrangle (area B), and southwest from Marquand to beyond Greenville (area C). Moreover, we estimate that if each of these postulated deposits is similar to the nearby deposits of the same type, then the metals in the ground in these deposits would have a combined total value on the order of 3 billion dollars, using metal prices of September 30, 1980. The cobalt that may be present in these deposits would be of special importance to the United States, because nearly all of this critically important metal is currently imported from politically unstable regions; the resource here could amount to as much as 30–55 million pounds, on the order of 2–3 years' consumption. (Even now, the Madison mine near Fredericktown is being reopened to recover its cobalt and nickel resources.)

The other type of deposit for which a very high potential exists is large to moderate-sized underground deposits of high-grade iron ores of the type that have been mined at Pilot Knob and are known to exist at Boss and Camels Hump (see fig. 1). Three areas in the quadrangle have a very high potential for deposits of this type: these areas are northeast of Lake Spring (fig. 2, area D), between Potosi and Belgrade (area E), and northeast of Bonne Terre (area F).

In addition, a large area in the north-central part of the quadrangle has a high potential for small barite deposits in the clayey subsoil near the surface, which though individually small could be cumulatively large (fig. 3, area A); an irregular area extending north and west from Fredericktown has a high potential for small vein deposits of tin and tungsten near the surface (area B); and much of the quadrangle may have a high potential for uranium deposits in granitic rocks at depths of 1,000 feet or more beneath the surface. Three areas contain occurrences of kimberlitic rocks (fig. 3, areas C, D, and E), and may have a potential for deeply buried veins of rare-earth minerals and thorium, as well as diamonds, but the information on these areas is too scanty for us to say how great this potential is. Likewise, an apparent but unappraisable potential exists in several areas for uranium deposits in sandstones, and for deeply buried copper-nickel-cobalt-chromium-platinum deposits. Small deposits of manganese, iron, and copper minerals may exist in several areas of the quadrangle but would not be of commercial interest in the near future, either because they would be too small or because their physical properties would not be suited to present-day ore-processing requirements.

Important resources of industrial, nonmetallic minerals, notably cement-grade limestone, agricultural limestone, construction stone, and industrial sand, probably occur in the quadrangle but are only now being evaluated as a part of the Rolla 1°×2° study.

REFERENCE CITED

Pratt, W. P., editor, 1981, Metallic mineral-resource potential of the Rolla 1°×2° quadrangle, Missouri, as appraised in September 1980: U.S. Geological Survey Open-File Report 81–518, 82 p.

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