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ISOTOPE INVESTIGATIONS ON CARBONATE ROCKS HOSTED LEAD-ZINC DEPOSITS FROM BAMBUÍ GROUP, MINAS GERAIS, BRAZIL: IMPLICATIONS FOR ORE GENESIS AND PROSPECT EVALUATION

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The Bambuí Group, a sedimentary cover of hundreds of meters thick, extends over an area of more than 400,000 km^2 in central Brazil. This is an important stratigraphic unit hosting major lead-zinc deposits, which are considered to be of the *Mississippi Valley Type* (MVT). Extensive geological, geochemical and isotope investigations have been carried out on the MVT deposits of North America, which have led to the formulation of different genetic models for the ore deposits. In contrast, geological and geochemical (especially isotopic) investigations on the Bambuí deposits have been limited. However, these preliminary study have yielded important information on the time of mineralization, and sources of metal and sulfur (IYER 1984; IYER *et al.* 1992). The study also provided some clues for ore prospecting. A review of the isotope data from Bambuí Group and their implications is presented in this paper. The nature of further systematic study to elucidate a comprehensive genetic model for the lead-zinc deposits is discussed.

Lead isotope data for thirty-eight galenas throughout the area seem to imply a two stage evolution. In the first stage, during the Transamazonian orogeny (1860 ± 150 Ma), the lead isotope system homogenized to a certain degree and then probably U/Pb and Th/Pb fractionation occurred. The second stage of evolution started with the growth of the lead isotope ratios and terminated at about 600 ± 100 Ma ago, when the lead was incorporated into galenas. The large scatter of the data makes it difficult to pinpoint the exact time of the incorporation of lead in the galenas.

In the region of Vazante-Paracatu, a major fault zone on the western margin, the lead isotope system *appears* to have evolved under single stage conditions during the Brasiliano orogeny. Twelve galena samples from this region show uniform and nonradiogenic lead isotope compositions. The calculated $^{207}Pb/^{206}Pb$ model ages for these samples fall within 600 to 750 Ma. Depositional age of 650 Ma was determined for the pelitic rocks of the Bambuí Group by Rb/Sr method (PARENTI COUTO *et al.* 1981). The Pb/Pb dating of the carbonate rocks has shown a complex isotope evolution history, suggesting depositional ages older than 690 Ma (BABINSKI *et al.* this Symposium).

There is interesting geographical zoning near the Vazante-Paracatu area, with lead becoming more radiogenic towards the east (IYER 1984; BABINSKI & IYER 1987). Similar *isoplumb* lines are observed in other areas and have been interpreted as reflecting the direction of solution flow, buried heat sources, and the area of localization of ore fluids. The lead isotopes in galenas appear to follow the trend in the zoning of lead isotopes. In the Vazante-Paracatu area mobilization of large quantities of lead (probably from feldspar, which is generally nonradiogenic) took place and this lead seems to have evolved under conditions approaching single stage.

The lead isotope distributions, combined with current knowledge of the occurrences of different types of mineral deposits, can be used for prospecting and evaluation of ore deposits. Most base metal deposits of the world have evolved under conditions approaching single stage growth (DOE & STACEY 1974). The lead isotope ratios of galenas from Vazante-Paracatu area conform to this general trend. Leads of anomalous isotope values are encountered in the peripheral regions. Additional work may reveal a reversal of the zoning of the isotope ratios and may point to other economic deposits.

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The sulfur isotope analysis of twenty-five galenas from Bambuí showed a large variation in $\delta^{34}S$ in the range of + 19‰ to + 28‰. The sulfur isotope data do not show any correlation with the lead isotope values, implying different sources for lead and sulfur. Paleogeographic data seem to support this conclusion. The isotopically heavy sulfides appear to have been generated by the reduction of contemporary sea water sulfates. The inferred age of the sea water (based on the $\delta^{34}S$ and $\delta^{18}O$ of barite samples) appear to be concordant with the age data obtained from radiometric and paleogeographic studies. The mechanism of sulfate reduction in the area is not fully understood. Recent studies indicate a genetic link between the occurrences of organic carbon and the sulfite ores in many MVT deposits. In the Bambuí Group, organic carbon is present in quantities varying from 0.1 to 2%.

Systematic lead and sulfur isotope analyses on sulfite minerals from different Pb–Zn deposits of Bambuí, with special emphasis on these from the Vazante-Paracatu area, will provide information on the following aspects:

1. The extend and nature of lead isotope homogeneity in the Vazante-Paracatu area;
2. Better definition of lead isotope model ages in the Vazante-Paracatu region;
3. Geographic distribution of lead isotope ratios and comparison of lead isotope ratios of prospects and proven ore deposits;
4. Extent of sulfur isotope equilibrium among coexisting sulfite minerals (if equilibrium is identified, temperatures can be derived);
5. Sulfur isotope analyses of sulfate minerals and possible relation to contemporary sea water;
6. Role of organic carbon in ore genesis;
7. Elucidation of genetic model for the ore deposits of Vazante-Paracatu and comparison with ore genesis models for the MVT deposits from other areas.

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