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Implications of New Geophysical and Lead Isotopic Data on Localization of Giant Zinc Sulphide Body at Agucha in Western India

Golani, P. R.[1], Soni, L. K.[2] and Bhamboo,Y. S[2].

[1]Geological Survey of India, Training Institute, Bandlaguda, Hyderabad-500 068, email: prggsi@gmail.com
[2]Geological Survey of India, Western Region, Jhalana Dungri, Jaipur-302 004, India

Isolated 'pull-apart' type basins in the Archaean banded gneissic terrain are repository of several sediment-hosted Pb-Zn (-Ag) deposits in the state of Rajasthan in western India. The 120 Mt Pb-Zn (2.0% Pb + 13.9% Zn, Ag 63ppm) deposit at Agucha is the single largest zinc-dominated sulphide ore body in the world that is hosted by a high grade sequence of sillimanite-garnet (±graphite) bearing gneisses, granite gneiss, calc-silicate rocks and amphibolite.The ore body occurs in gneissic terrain close to its contact with reworked Archaean Sandmata Granulite Complex. The 1500 m long NE-SW trending Agucha ore body is fairly uniform, moderate to steep southeasterly dipping wedge-shaped sulphide sheet that has an average thickness of about 60m and a down dip extent to about 1100m. The semi-massive orebody is an assemblage of sphalerite, galena, pyrite, pyrrhotite, graphite (7 to 10%) and gangue minerals (45-50%) mainly quartz, k-feldspar, plagioclase, sericite, chlorite, biotite and sillimanite. The Agucha mine sequence is strongly sheared with evidence of latter brittle deformation represented by pseudotachylytes. At deeper levels the ore body is wrapped up by galena and silver-rich (0.1%) mineral phases.

Recently carried out geophysical mapping of about 10,000 sq km area on 1: 50K indicates existence of NW-SE trending lineaments that are also locales of a series hitherto unknown isolated gravity highs [1]. It substantiates the earlier recorded NW-SE trending discrete aero-magnetic discontinuities that intersect with more prevalent NE-SW aeromagnetic discontinuities at Agucha. Field examination reveals that some of the gravity highs coincide with gabbroic plugs. Ground geophysical surveys on Agucha mine block also brings out 2 mgal gravity high over sulphides and a magnetic discontinuity across the ore body itself. Gravity mapping data in the NE-SW trending Sandmata Granulites and banded gneissic region indicate that the contact between the two needs to be shifted further to the southwest than the one brought out during geological mapping.

The lead isotopic ratios in five galena separates from Agucha show a very restricted range $^{206}Pb/^{204}Pb$ (16.05130 – 16.05884), $^{207}Pb/^{204}Pb$ (15.50264 – 15.51536) and $^{208}Pb/^{204}Pb$ (35.80089 – 35.83772). The narrow spread in these limited numbers of lead isotopic ratios indicate that initial Pb isotopic compositions are less radiogenic and quite well preserved. The reported values best approximate to lower crustal material. It further indicates that the ores probably did not experience any significant crustal reworking in post-emplacement period.

Integration of geological and geophysical attributes indicates that the localization of Agucha sulphides is associated with availability of favorable lithology, intersection of magnetic discontinuities and occupation of NE-SW and NW-SE trending lineaments with basic magmatic bodies. From the exploration perspective, the geological, geophysical and limited Pb isotopic data indicate that Agucha sulphides are located close to a major geodynamic boundary that has involved lower crust during its metallogenic evolution. Intersection of NW-SE lineaments with the NE-SW trendingterrain boundary between Sandmata Granulites and banded gneisses provides potential targets for base metal exploration.

References:

[1] Bangaru Babu et al. (2015) Geol. Surv. India Spec. Publ. No. 101, 97-108.