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Geochemical and textural attributes of magnetite–apatite mineralization in Dhantuppa, Singhbhum Shear Zone, eastern India

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The polymetallic, Paleoproterozoic Singhbhum Shear Zone (SSZ) hosts several Fe–oxide–Cu–Au (IOCG) and Fe–oxide apatite (IOA) type deposits. In Dhantuppa, IOA-type magnetite–fluorapatite pods of 10s of meter dimension are hosted in mafic igneous rock. Three textural variants are seen - magnetite–apatite of ilmenite-poor nelsonitic variety (Assemblage I), magnetite–apatite associated with biotite (Assemblage II) and magnetite–apatite with chlorite and chloritized biotite (Assemblage III). Large monazite and xenotime (> 500 μm) are present only in the first two assemblages.

The magnetite of Assemblage I and II are enriched in Ti, V, Ga and Sn suggesting a higher temperature of crystallization in case of those two assemblages compared to Assemblage III. Thermometric calculation based on concentration of Mg in magnetite yields the highest temperature for Assemblage I, followed by Assemblage II and III. Based on vanadium concentration of co-existing apatite and magnetite we infer that, Assemblage I and II formed at comparatively lower fO_2 than Assemblage III. Large enrichment of LREEs in apatite along with the ubiquitous presence of monazite and xenotime in Assemblage I and II indicate REE-enriched source for the parental melt/fluid responsible for the magnetite–apatite mineralization at Dhantuppa.

In the most widely used discriminator to identify deposit-type (Ti + V vs. Al + Mn and Ti + V vs. Ni/Cr + Mn) based on magnetite chemistry [1], all the magnetites of Assemblage I and II are plotted in the domain of Fe–Ti, V deposit; assigned to magnetite formed by orthomagmatic processes, whereas the Assemblage-III magnetites plot around the domain of Kiruna-type deposits. Considering the mafic nature of the host rock of magnetite–apatite mineralization, near-nelsonitic appearance of Assemblage I, significant enrichment of temperature-sensitive elements in magnetite and consequently being classified to belong to Fe–Ti, V deposits, indicate that the magnetite–apatite mineralization at Dhantuppa likely formed by magmatic/magmatic–hydrothermal process.

References

[1] Dupuis, C., Beaudoin, G., 2011. Discriminant diagrams for iron oxide trace element fingerprinting of mineral deposit types. Miner. Depos. 46, 319–335. https://doi.org/10.1007/s00126-011-0334-y