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The enigma of large scale ZnS-remobilization at Rampura-Agucha, Rajasthan, India.

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The Rampura–Agucha Zn–Pb–(Ag) deposit is hosted within a high-grade metamorphic enclave of the Bhilwara Supergroup, comprising graphite-bearing garnet–biotite–sillimanite gneisses interlayered with amphibolites and pegmatites. This volcano-sedimentary sequence formed in a Proterozoic extensional basin and was subsequently subjected to upper amphibolite- to granulite-facies metamorphism and deformation. Partial melting of sulfide ore during high-grade metamorphism (peak conditions of ~6.2 kbar and 720–780 °C) is well established [1], with post-peak temperature resetting to 580–610 °C also noted [1]. Equilibria among sphalerite, pyrrhotite and pyrite yield peak pressures of ~6.3 kbar, while textural evidence for incongruent pyrite melting indicates temperatures exceeding ~743 °C, corroborating peak metamorphic conditions. Garnet–biotite geothermometry [2] and GASP geobarometry [3] applied to host metapelites and amphibolites yield temperatures of 516 ± 15 to 587 ± 20 °C and pressures of 5.3 ± 0.4 to 6.6 ± 1.1 kbar (Fig. 1), representing post-peak cooling. As shown in Fig. 2, brittle pyrite and silicate grains are entrained within a ductile matrix of pyrrhotite, sphalerite, graphite and pyrite, forming a Durchbewegung structure, implying syn-metamorphic sulfide mobilization during ductile deformation. The large-scale remobilization of refractory sphalerite (m.p. ≈1680 °C) presents a thermodynamic paradox. Based on experimental observations, desulfurization of sphalerite at high temperature may cause Zn transport as a transient metallic melt (m.p. 419 °C), which when comes in contact with pyrite is re-sulfidized to sphalerite. These observations suggest a mechanism for large-scale sphalerite remobilization, perceived otherwise improbable.

[1] Mishra, B. and Bernhardt, H.-J. (2009) Miner Deposita 44: 183-204

[2] Kaneko, Y. and Miyano, T. (2004) Lithos 73, 3-4: 255-269

[3] Wu, C. M. (2019). Original Calibration of a Garnet Geobarometer in Metapelite. Minerals, 9(9), 540.

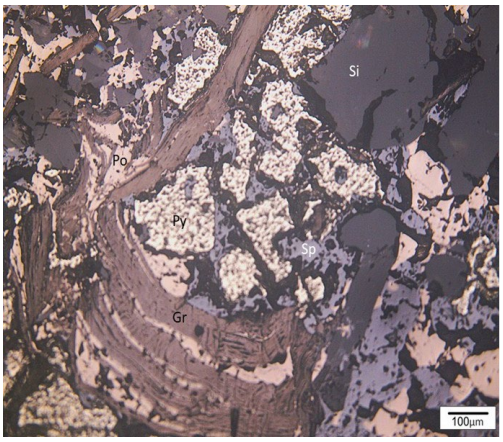


Fig. 2. Photomicrograph depicting brittle pyrite and silicate (Si) grains swept in a ductile mass of sphalerite (Sp), pyrrhotite (Po), and graphite (Gr).

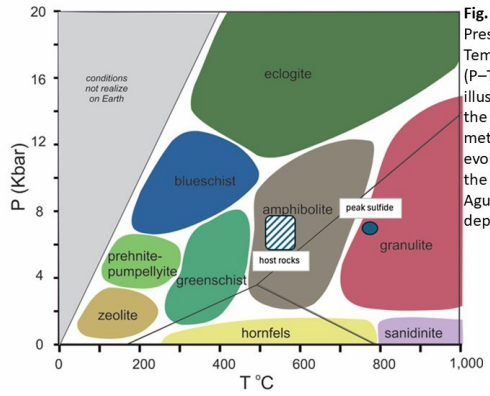


Fig. 1. Pressure–Temperature (P–T) diagram illustrating the metamorphic evolution of the Rampura–Agucha deposit.