Records of Proterozoic magmatism and Himalayan exhumation in sulphide minerals and fluid inclusions from the klippen rocks of Lesser Himalayan tectonic domain

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The genetic environment of sulphide ores from the klippen rocks of the Lesser Himalaya in Garhwal and Kumaun has been investigated to understand the processes operated in the Proterozoic rock suit. The characteristic minerals, together with chemical data point to the primary deposition of ores, and in turn the Proterozoic environment of the host crystalline rocks. Features of complex mineral assemblage suggest activity of hydrothermal fluids. The composition of cubanite lamellae reveals its transformation from high temperature form, myrmekitic intergrowth of stannoidite in chalcopyrite and Zn content in it, togther with $\delta^{34}S$ values in range of 0.9 to 6.8 ‰ attribute to the shallow magmatic process during syngenetic ore formation in the crystalline rocks. Arsenopyrite compositions further imply 450±20°C formation temperatures. Fluid inclusions in the ore mineral assemblage suggest high volatile contents in the ore forming fluid, and the micro Raman spectroscopy confirms CO_2 with significant CH_4 in the fluid, which is unusual to general metamorphic sequence in Lesser Himalaya. Liquid-vapour coexistence and fluid separation was prominent in the shallow magmatic system. These features are in alignment with the chemical signatures of granitoids from the mineralized Askot and Chiplakot klippen, which are interpreted to have hybrid source, and represent active arc around 1800 Ma.

The fluid inclusions in the selected minerals from the assemblage help to understand the imprints of the exhumation of the host rock sequence. Early fluid inclusions in gneisses show their re-equilibration to the stretched cavities as a result of dissolution-crystallization process. Such inclusions occurring in the fluid inclusion arrays are oriented perpendicular to the stress, and were deformed subsequent to a regional stress generated by Himalayan thrusting. The Himalayan exhumation is apparent from the excess internal pressure developed within inclusions in the exhumed rocks. The features observed near the thrust plane further points to the isothermal decompression and rapid uplift.

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