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Mechanisms of secondary mineralization at shallow crustal depths of the Koyna Seismogenic region, Maharashtra, India and its significance

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The Koyna region in the Western part of the Indian Subcontinent has been experiencing numerous low to moderate earthquakes since the construction of the Koyna Dam. A Continental Deep Drilling Programme has been initiated to investigate this recurring seismicity. The Granitic core samples recovered from the KBH1 Borehole near Rasati in Koyna Intraplate Seismogenic region exhibits several mesoscopic signatures of fluid percolation through existing fractures. FESEM and XRD analyses have inferred the presence of clinochlore, illite and calcite whereas, optical microscopic study reveals the association of epidote & biotite, dissolution of mineral surfaces, numerous biotite veins at many places. The altered zone has been noticed within the depth range of 1027 m and 1286 m, where the clinochlore-epidote has been observed at shallow depth and illite-calcite assemblage has been found more prominently with increasing depth. This secondary mineral assemblage basically indicates the propylitic facies of supergene hydrothermal alteration in the granitic basement in which the occurrence of chlorite reflects the temperatures above 220°C. On the other hand, illite is generally formed at 130°-160°C but here illite has been formed at greater depth than chlorite, so the formation temperature of illite can be interpreted as ≥ 220°C which may be due to the increasing activity of K^+/H^+ and the decreasing function of Mg^{2+}/H^+. Actually, the top basaltic rock of the Koyna region contains relatively high MgO (≈ 8–13 wt.%) so the infiltrating fluid causes high Mg activity at shallow depth which diminishes with increasing depth. Side by side, the low K^+/H^+ ratio and low activity of silica facilitate the dissolution of feldspar by the meteoric water which supplies the required K^+ in the system and provides the sufficient energy threshold for illitization even at greater depth. So, our present study gives a significant insight on the mechanism of secondary mineralisation due to fluid-rock interaction at shallow crustal depth which has a great role in triggering seismicity, because epidote increases the potential for inducing seismicity on existing faults and chlorite lowers the frictional strength. Thus, co-seismic fluid-rock interaction exerts a subtle but significant control on recurring seismicity in Koyna Seismogenic region.