CHARACTERIZATION OF BLACK SCHIST OCCURRENCES AND SULFUR EMISSIONS IN THE UPPER TRISHULI VALLEY, CENTRAL NEPAL

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Several magneto-telluric surveys have revealed mid-crustal conductive regions in the Main Central Thrust (MCT) zone, partially associated with seismic activity. The high polarizability and frequency-dependent electrical conductivity of black schist in this zone has suggested the role of this rock-type bearing graphite to the crustal conductivity structure of the MCT zone. Electrical anomalies have also been detected in the vicinity of the numerous hydrothermal systems located in the MCT zone, sometimes associated with sulfur deposits. Besides, these systems exhibit large carbon dioxide (CO_2) emissions, sometimes carrying hydrogen sulfide (H_2S) to the surface. This CO_2, likely produced in the upper crust by metamorphic reactions at more than 5 km depth, has been strongly affected by the 2015 7.8 Mw Gorkha earthquake in Central Nepal.

Based on a multidisciplinary approach, we characterized the occurrences of graphite-rich black schist and H_2S emissions in the Upper Trishuli Valley, Central Nepal. At two black schist outcrops we studied: (1) geology and petrology with a combination of X-ray diffraction analysis, scanning electron microscopy and Raman spectroscopy; (2) geochemistry with sulfur isotopes determination ($\delta^{34}S$); and (3) sub-surface geophysical soundings using Electrical Resistivity Tomography (ERT), Induced Polarization (IP), and, for the first time, Spectral Induced-Polarization (SIP). Gaseous and dissolved sulfur emissions are characterized, by the measurement of H_2S flux at the Syabru-Bensi hydrothermal system based on the accumulation chamber method and by the measurement of dissolved sulfate content and $\delta^{34}S$ values at various hot spring locations of the valley, respectively.

Our result shows that the black schist outcrops are characterized by spatial variations of graphite content and conductive signals imaged by ERT, IP and SIP. Associated with spatial variations of metamorphic CO_2 flux over 5 to 6 orders of magnitude, H_2S fluxes on the ground range over more than 3 orders of magnitude (from 0.1 to >10 g m^{-2} d^{-1}), revealing interesting relationships with CO_2 fluxes. The obtained $\delta^{34}S$ values also help us to constrain the origin of sulfur in this area. All unprecedented combined observations suggest that carbon and sulfur, under various forms, are present in the MCT zone and might play an essential role during the Himalayan seismic cycle.

Keywords: H_2S, CO_2, Black Schist, Spectral Induced Polarization, MCT.