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Rock Magnetic Studies of Three Soil Profiles from the Tropical Coastal Low-Lands of Karnataka, Southern India

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Soil is an important and crucial component of our environment. It is necessary for plant growth-agricultural, horticultural, forest etc. Soil studies are important because India is primarily an agricultural country. Of the several approaches used to understand soil genesis, the rock magnetic approach offers important insights into the formation, transformation and dissolution of magnetic minerals in soils. Although numerous rock magnetic studies have been carried out on temperate soils, soils of tropical regions have not been the focus of detailed rock magnetic investigations. We are investigating the rock magnetic properties of soils that have developed on different lithologies, in different topographies and under different climatic conditions (rainfall and temperature). We present here the preliminary results (mass specific magnetic susceptibility (Xlf), percentage frequency-dependent magnetic susceptibility (Xfd %), susceptibility of anhysteretic remanent magnetization (Xarm), Xarm/Xlf, pH and electrical conductivity) obtained on three soil profiles - Vittala, Othinakatte and Dharmasthala. All the three profiles have developed on Peninsular/granitic gneisses in the coastal low-lands of Karnataka. This area has a tropical climate and receives high rainfall. In spite of the similar parent rock material and similar climate, the magnetic susceptibility values change by more than an order of magnitude ($\sim$ 40 to 1100x10-8 m3/kg) in the three profiles. Possible reasons can be variations in the composition of the parent rock and pedogenic formation of magnetic minerals. The formation of super-paramagnetic (SP) grains of magnetite during soil formation is indicated by Xfd % in the Vittala and Othinakatte profiles. However, SP grains may not be the sole contributor to magnetic susceptibility. The low Xlf values suggest the presence of antiferromagnetic minerals like haematite and goethite. This is also suggested by the negative correlation between Xfd % and Xlf (r = -0.53). However, in the Dharmasthala profile, Xlf and Xfd % are positively correlated (r = 0.68). The magnetic minerals here seem to be of SP grain size because 1) Xarm values are low (0.25 to 0.75 x 10-5 m3 kg-1) suggesting that magnetic minerals are not of the stable single domain grain size; 2) Xfd %, which is indicative of SP grain size, is significant ($\sim$ 5-13 %); and 3) Xfd % is significantly correlated with Xlf (r = 0.68). In the Othinakatte profile, high susceptibility is due to the presence of both SP and multi-domain magnetic grains because 1) there is a good correlation between Xlf and Xfd; 2) Xarm and Xarm/Xlf are low; and 3) SIRM/Xlf is high ($\sim$ 6, 250 to 9, 500 A/m). The very low Xarm/Xlf ratio ($<$ 5) in the Vittala profile suggests that magnetic minerals may not be of SD grain size. Xlf and SIRM values are positively correlated (0.69). The high SIRM/Xlf ratio suggests that the magnetic

minerals are of multi-domain magnetite with some amount of anti-ferromagnetic minerals. pH and electrical conductivity are negatively correlated in the Vittala profile, to a large extent in the Othinakatte profile and in the upper part of the Dharmasthala profile. The preliminary results show some similarities, in spite of differences, in the distribution of magnetic minerals. There are definite indications of pedogenic formation of magnetic minerals in the three profiles studied. In addition, there is no enhancement in Xlf in the top portion of the soil profiles. In fact, concentration-dependant parameters decrease towards profile-top, indicating that magnetic minerals have been eroded from the site. Results of more detailed investigations (pedogenic susceptibility, particle size-specific magnetic data, TEM/XRD) would be presented at the Meeting.