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Magnetic susceptibility as a proxy for paleorainfall: New data from Hirekolale lake sediments, Southern India

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Shankar et al. [1] proposed magnetic susceptibilityas a proxy for rainfall in tropical regions. In continuation, we investigated a 110-cm long sediment core from Hirekolale Lake (Chikkamagalur District, Karnataka State). The catchment rocks come under the Bababudan Group with granitic gneisses,schists and banded iron formations.The annual average rainfall is 1925 mm that is received mainly during the southwest monsoon. The core was sub-sampled at 0.3 cm interval; all the subsamples were measured for rock magnetic parameters [magnetic susceptibility (χ_{lf}), frequency-dependent susceptibility (χ_{fd}) percentage frequency-dependent susceptibility ($\chi_{fd\%}$), susceptibility of anhysteretic remanent magnetization (χ_{ARM}), saturation isothermal remanent magnetization (SIRM), and “hard”isothermal remanent magnetization (HIRM) and inter-parametric ratios like χ_{ARM}/χ_{lf}, χ_{ARM}/χ_{fd}, χ_{ARM}/SIRM, SIRM/χ_{lf} and S-ratio]. Besides, sedimentological analysis was carried out to determine the relationship between magnetic mineral concentration and particle size. Geochronology was obtained by AMS C-14 dating of bulk organic carbon in the sediment samples.

Carbon-14 dates indicate that the core spans the past 1254 cal. yr. The rock magnetic data suggest that there is no greigite, biogenic or anthropogenic magnetite nor is there dissolution of magnetic minerals in the samples. Hence, the magnetic signal in the HK lake sediments must be catchment-derived. A study of HK catchment soils (see abstract by Shetty and Shankar, 2016; This volume) suggests that pedogenic magnetite is produced during chemical weathering. Hence, HK lake sediments constitute a natural archive from which paleoclimatic data may be discerned. Magnetic susceptibility is significantly correlated with rainfall for Peninsular India (r = 0.48), All-India (r = 0.36), Karnataka (r = 0.34), and Chikkamagalur Station (r = 0.21). Hence, rock magnetic data of HK core may be used for paleorainfall reconstruction. Surprisingly, rainfall is not positively correlated with χ_{fd}.

Based on the down-core variations of χlf, the core may be divided into three zones: Zone 1 (1254 -789 cal. yr. B.P.), Zone 2 (785 - 368cal.yr. B.P.) and Zone 3 (364calyr B.P. - Present). In Zone 1, concentration-dependant rock magnetic parameter (χlf, χfd, χARM and SIRM) values indicate a low magnetic mineral concentration. The sand content is high and negatively correlated with χlf. This suggests low rainfall/arid conditions in the catchment during the period 1254-789 cal. yr. B.P. In Zone 2, χlf, χfd, χARM and SIRM values indicate a relatively high concentration of magnetic minerals, indicating high rainfall conditions compared to Zone 1. High rainfall from 785-599 cal. yr. B.P. (AD 1165-1351) corresponds to the Medieval Warm Period (MWP; 1100-1400 AD). In Zone 3, concentration-dependant rock magnetic parameter values indicatean even higher concentration of magnetic minerals compared to Zones1 and 2, indicating much higher rainfall conditions. Magnetic susceptibility is significantly correlated with sand %, indicating significantly high rainfall conditions in the catchment that led to a marked input of coarse sediments to the lake. The high χlf (= high rainfall) recorded during AD 1593-1672 (= 357-278 cal. yr. B.P.) corresponds with the high rainfall reported from other regions: (a) in AD 1640 deciphered for

Chitradurga region, Southern India [1], (b) in AD 1666 documented for western India [2], and (c) in AD 1666 reported for Akalagavi speleothem north of HK [3].

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