Mars-Context Insight On Intraplate Serpentinization From Rupaha, Sri Lanka. V.M. Nair[1,2], A. Basu Sarbadhikari[1], Y. Srivastava[1,3], A. Rani[1,4], P.L. Dharmapriya[6], S.P.K. Malaviarachchi[6], E.B. Hughes[7], S. Karunatillake[5], J.J. Wray[7], D. Nisson[8], M. Melwani Daswani[9]. (varsha@prl.res.in) [1]Physical Research Laboratory, Ahmedabad, India; [2]Indian Institute of Technology Gandhinagar, Gujarat, India; [3]Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA 92093-0244, USA; [4]Marshall Spaceflight Center, Huntsville, AL, USA; [5]Geology & Geophysics, LSU; [6]Department of Geology, U. of Peradeniya, Sri Lanka; [7]Earth and Atmospheric Sciences, Georgia Tech 30332; [8]Geosciences, Princeton University, Princeton, NJ 08544, USA; [9]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, USA.

Introduction: The hydrolytic alteration of ferromagnesian minerals like olivine and pyroxenes, producing H_2-rich fluids and facilitating carbon reduction, leading to organic compound synthesis under various physico-chemical conditions [1], makes serpentinization ideal for habitability. Orbital mineral detections indicate paleo-serpentinization on Mars, suggesting liquid-water-ultramafic alteration [2,3]. Although, the unavailability of retrieved samples restrict us in detailed geochemical investigation, serpentinites on Earth, such as those found in Rupaha, as an intra-plate anomaly in the Highland Complex (HC) Sri Lanka, can yield critical context for Martian serpentinization [1,3].

Results: Rupaha's serpentinites may reflect a Neoproterozoic mantle unit entrained within HC during an island-forming double-sided subduction closing a Mozambique Paleo-Ocean Branch [4]. Rupaha's serpentinites (elevation 1040 m) extend semi-contiguously over 2 km at several meters thickness [5,6] and cross-cuts the proterozoic garnetiferous gneiss country rock. A field examination of serpentinites reveals color variations, ranging from dark to pale green, consistent with variable serpentinization.

Our analyses indicate that the dark green rocks preserve unaltered olivine (Mg# 95-99) and pyroxene (Mg# 97-99) in a mesh texture, presumably preserved from their ultramafic protoliths. However, the pale green samples lack relict olivine, suggesting a higher degree of serpentinization. The pale green rocks also contain microscopic carbonate veins.

Discussion: Rupaha's intraplate serpentinization provides a distinct analog for Mars, complementing Earth's plate boundary-associated serpentinite bodies [5,6,7]. The coexistence of olivine-rich rocks undergoing serpentinization associated with magnesium carbonates is akin to observation in the Nilli fossae region of Mars [2]. Our literature survey reveals no significant changes in bulk composition between protoliths and serpentinized rocks within the same geological bodies, underscoring the isochemical nature of serpentinization. For reference, we evaluate Rupaha's serpentinites with other Earth sites, and available protolith data [8,9,10] in a ternary diagram (**Fig. 1**) and compared with the composition of the bulk silicate Earth (BSE) and the Martian compositions. Earth serpentinites are found in the Mg- and Fe-rich domains [8]. This suggests that more Fe-rich serpentinite protoliths could have originated from the melting of BSE. In contrast, protoliths of the Mg-rich serpentinites may be linked to mantle residue melting.

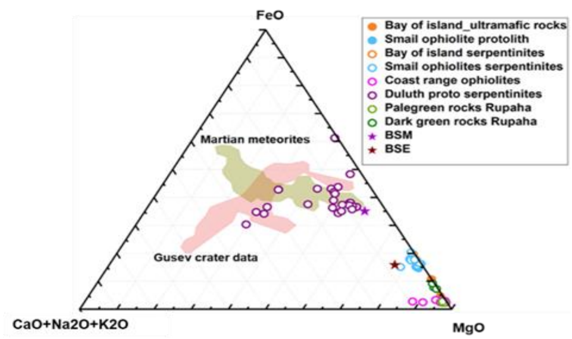

Figure 1*: Ternary diagram showing the bulk rock composition of serpentinites and some of the exposed protoliths. The shaded regions represent the range of Martian in situ (Gusev) and meteoritic data.*

Applying this paradigm to Mars, which exhibits a more Fe-rich composition than the BSM, we anticipate the presence of Fe-rich serpentines in the Martian settings. Satellite-IR data on Mars suggest Mg-rich serpentines and carbonates [11]. However, ongoing observation, including in situ at Jezero crater, prompts a revisiting of the serpentine mineralogy [12]. This apparent disparity prompts further investigation into the complex serpentinization processes on the Martian surface.

References: [1] Holm, N. G. et al. (2015) *Astrobio., 15.7*, 587-600. 12818-12823. [2] Ehlmann, B. L. et al. (2010) *GRL, 37*, L06201. [3] Ojha, L. et al. (2021) *Nat. com.,12.*, 1754. [4] Santosh et al. 2014, *Prec. Res. 255*,1-29. [5] Fernando, G. W. A. R. et al. (2013) *J. of Geo. Soc. of Sri Lanka, 15*, 163-181. [6] Fernando, G. W. A. R. et al. (2017) *Lithos, 284*, 237-256. [7] Dick, H. J. B. et al. (2003) *Nature, 426*, 405. [8] Tutolo, B. M. and Tosca, N. J. (2023) *Sci. Adv., 9(5)*, eadd8472. [9] Snortum, E. and Day, J. M. (2020) *Chem. Geol., 550*, 119723. [10] Klaessens, D. et al. (2021) J. *Geophys. Res.Solid Earth*, 126.10,e2021JB021977. [11] Wray, J. J. et al. (2016) *JGRPlanets, 121(4)*, 652-677. [12] SPK Malaviarachchi et al. (2024) *LPI Contr*i. 3040.