

Montmorillonite catalysis and potential of charge density in proposing the target sites on Mars for search of organics

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Montmorillonite, a member of phyllosilicate group minerals, which have been identified on martian soil, serves as catalyst for the non-enzymatic formation of RNA-like oligomers in aqueous solution [1]. Extent of catalysis widely varies with the region where montmorillonite is mined [2, 3]. While oxide composition of montmorillonites varies within narrow limits, their charge densities resulting from isomorphous substitutions fluctuate to a larger extent.

Research designed to investigate whether there exists a relation between the layer charge density of montmorillonites mined in different regions, and the extent of their catalytic activity demonstrates that montmorillonites with low charge density exhibit higher catalytic activity, Table 1.

Table 1. Mean layer charge of montmorillonites per formula unit, χ , length of the longest oligomers, and their % yields.

Charge density of montmorillonites can be determined by measuring the $d_{(001)}$ spacing of [mineral- alkyl ammonium-mineral] complexes by XRD [4]. Charge density can also be calculated from the chemical analysis results [5]

During NASA's next rover mission to Mars, CheMin (CHEmistry and MINeralogy) will provide information on the mineralogical, and elemental analysis of the samples by combined application of XRD and XRF. Therefore, results obtained in this work may play a significant role in determining the target sites on Mars in future missions for the search of organic compounds, and extinct or extant life.

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[2] Kawamura & Ferris (1994) *J. Am. Chem. Soc.* **116**, 7564–7572. [3] Ertem (2004) *Origins Life Evol. Biosphere* **34**, 549–570. [4] Lagaly & Weiss (1970) *Kolloid Z. und Z. Polymere* **237**, 266–273, 364–368. [5] Köster, H.M. (1977) *Clay Minerals* **12**, 45–54.

Insights from comparisons of two Lau Back-arc Spreading Centers

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Eastern Lau Spreading Center (ELSC) and Fonualei Spreading Center (FSC) are two independent systems in the southern and northern Lau Basin, respectively. Both spreading centers are closest to the Tonga arc front at their southern extremity, and increase in distance northwards. The distance from the arc with latitude increases twice as fast for the FSC for a similar latitude interval.

Trace element and Pb-Sr-Nd isotope data for >110 samples from ELSC and >60 from FSC permit a comparison of how back-arcs vary along strike and with distance from the arc. While to first order the subduction input to back-arc lavas decreases with distance from the arc front, the back-arc composition and flux also oscillates along-strike in tandem with the arc front. Directly behind volcanoes of the arc front, the back-arc is shallower and contains more subduction input that corresponds with the particular composition of the arc front volcano. This observation precludes major along-strike flow of the mantle wedge to influence the mantle that feeds the back-arc. Differences in subduction input in north and

	χ	Length	% Yield
Otay	0.37	4	0.05
Vol	0.29	10	0.07
Japan	0.29	9	0.04
Swy-2	0.29	9	0.11

south also influence both arc and back-arc, and back-arc lavas at similar distances vary in composition accordingly. The FSC also has less decrease in subduction input with distance than the ELSC, and a general 'pollution' of subduction influence. For the two spreading centers, this leads to trends with distance from the arc with slopes of the same sign but different values for analogue element ratios such as Nb/U, Ce/Pb, or Th/Nb. As a further contrast, for the FSC, the background mantle becomes progressively enriched northwards, a feature not observed in the south. As a consequence, trends with distance for the two spreading centers have opposite slope for Pb isotope ratios, La/Sm and Th/La.

These complexities show that global relationships of back-arc composition with distance to the arc do not exist. Subduction input varies along strike and the back-arc chemical composition does not change linearly with distance, but fluctuates at the same length scale as arc volcanoes; mantle wedge composition is an important factor; and some back-arcs are polluted by an arc component owing to their tectonic history.