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Molecular Mechanism of Basalt Alteration During Pedogenesis and Palagonitization: An Experimental Study

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Active volcanic fields are site for new rock formation and strat of weathering. Studies in Hawaii island and Iceland, active volcanic field, have reported two major active process, (1) Pedogenesis, the low-temperature alteration process, influenced by precipitation, topography, humidity and drainage conditions, resulting in short-ordered-range product, e.g., imogolite, allophane (hydrated aluminum silicate), (2) Palagonitisation, alteration under influence of hot water percolating through fractures resulting induration of tephra due to formation of ordered clay-like features and iron oxides. Current study has shown the pathways of pedogenesis and palagonitization under controlled experimental conditions. We have created three experiment setups mimicking natural precipitation with poor drainage conditions in hot and humid climates. Each setup is a closed chamber of vapour at three different temperatures 40° C, 60° C and 90° C. Basaltic glass has been kept in each chamber at three different heights in small teflon cup (0.5 ml), to receive varied precipitation due to condensation. In the low temperature (40 oC) and high humidity reaction condition, FTIR spectra show a sharp doublet in Si-O-Si stretching region, suggesting the formation of secondary product having Si-O-Si chain, the higher wave number peak (1200 cm-1) associated with silicate chain doublet indicates heavier atom, possibly Fe within the silicate chain structure, viz., further confirmed by Fe2p3/2 binding energy (709.7 eV), indicating Fe (III) in tetrahedral coordination environment, characteristic of sort range ordered silicates e.g. ferric silicates. The experiment at highest temperature (90 °C) has one sharp Si-O-Si stretching vibration peak in IR spectra, indicating a relatively long-range silicate structure. XPS spectra of secondary products in higher temperature (90 °C) experiment show binding energy of Fe and Mg, 711.2 eV and 50.4 eV, respectively, which is characteristic of dioctahedral sheet silicates as well as Fe oxy (hydroxides) (Elmi et al., 2016). Compositionally the secondary product could be mixture of both clay precursors and Fe oxy (hydroxides). Low temperature pathways results sort range ordered phases precursor while higher temperature alteration causes reorganisation and longer range growth of 2:1 phyllosilicate precursors.