Tectonic control of volcanism in Potassic Volcanic Belt in NE China

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Quaternary potassic volcanic rocks are found in several dispersed potassic volcanic fields in Heilongjiang province in NE China, including volcanic fields of Xiaogulihe, Keluo, Wudalianchi, and Erkeshan, composing a North-South trending potassic volcanic belt(PVB) in northeastern China. The volcanic belt extends for about 318km. All the volcanic fields in the PVB show a 160 degree linear arrangement with a separation distance of about 50km. Most of volcanoes in PVB are in Wudalianchi and Keluo. Cones in Keluo show 58 degree linear arrangement, and cones in Wudalianchi show 41 degree linear arrangement. Previous volcanism mode proposed that preexisting NE trending rifts controlled the distribution of cones in this belt, while the preexisting NNW-NS trending deep rift may control the upwelling of basaltic magma. Specially, Nen river fault, a pre-existing NNE trending normal fault on the surface and changes into a low angle detachment fault in the deep crust, are thought controlled the volcanism. However, this mode cannot explain the decoupled formation time and emplacement location between the fault or rift and the volcanic activity. The Nen river fault are formed in Mesozoic and Cenozoic, but the belt show apparent volcanism since middle Pleistocene. The volcanic belt are emplaced 100km far from the detected Nen river fault.

In the context of NE and NNE compression with dextral shearing in NE China in the present day, we propose that the coeval NS trending slip-strike deformation in lithosphere take an important part in controlling the volcanism, resulting in en echelon arrangement of NNE and NNE trending fractures in the deep lithosphere. Although the fractures are short in the lateral, they are vertical deep and can reach to mantle lithosphere, resulting in decompression and melting of magma source rocks. The magma ascends through these fractures, forming violent volcanic activity since middle Pleistocene.

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Non-linear rates of fluid-mineral reaction in metamorphic fluid flow

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It is well known that fluid-mineral reactions record the infiltration histories of fluid tracers (such as H_2O, CO_2 or CH_4) through the Earth's crust [1]. Early studies mainly employed linear reaction rate laws to model metamorphic fluid flow [e.g. 2-4]. Although some studies indicate that a linear reaction rate law is appropriate near equilibrium [e.g. 5, 6], Lasaga [7] concluded that reaction kinetics are likely to be non-linear in most fluid-mineral reactions. Therefore, the main objective of this study is to investigate the effects of non-linear reaction rate laws on metamorphic fluid flow parameterisations obtained using inversing modeling.

The transport model applied to metamorphic fluid flow with non-linear reaction kinetics was numerically solved and incorporated into a general inverse modeling framework based on the differential evolution method. The flux, duration of metamorphic fluid flow and rates of fluid-mineral reactions were constrained for four metamorphic sills with varying Péclet (Pe) and Damköhler (Nd) numbers in the SW Scottish Highlands. It is verified that the linear reaction rate law yields reliable first order estimates of time-averaged and time-integrated fluxes and the duration of metamorphic fluid flow. However, with increasing reaction order, the apparent reaction rate constant changed considerably. The magnitude of this effect is shown to be dependent on the combination of Pe and Nd. Our estimates of apparent reaction rate constants for non-linear reaction kinetics are in agreement with experimentally-based kinetic data based on linear reaction rate laws, but much larger than other measurements based on natural systems [6]. This indicates that accurate quantification of the order of fluid-mineral reactions is important if reaction rates are to be calculated.

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