Dynamic Differentiation and Association of Chemical Elements in Fault Zones

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Abstract

This paper deals with compositional variations in fault zones from a dynamic point of view. In the fault zones consisting of silicates, relative accumulation of Si and Fe is noticed in response to the leaching-out of K, Na, and to a lesser extent, Mg, Ca and Al. The order of petrologic elements from stable to mobile is tentatively suggested as follows: Si→Fe→Mg→Ca→Al→K→Na. The difference in ionic radius for these chemical elements is thought to be the major factor controlling dynamic differentiation. In the fault zones are silicates on one side and carbonates on the other, and new minerals are recognized in tectonites. On the silicate side Ca and Mg increase but Si and Al decrease; and the opposite is true on the carbonate side. This phenomenon indicates that migration of elements in the fault zones is accelerated by dynamic effect.

Introduction

In the early 1960s, J. S. Lee noticed that some quartz masses occurred in the compressive faults. This phenomenon was then called compressive segregation by geologists dealing with geomechanics. Lee suggested that tectonic stress not only gave rise to deformation, but also caused phase-transformation (e. g. chemical changes in rocks). His idea has greatly inspired us in the study of chemical changes in tectonites as a guide to the problem of faults.

Based on recent research work on faults, in combination with the characteristics of chemical changes in tectonites, four types of differentiation-association are distinguished: (1) mineral and chemical compositions generally unchanged, (2) extraneous components introduced in, (3) relative accumulation of some components due to the loss of other components in the fault zones consisting of silicate rocks, and (4) fault zones, with silicates on one side and carbonates on the other, characterized by both-side chemical compositions, where new minerals of Ca-Mg silicates in tectonites are formed. The latter two types are referred to as dynamic differentiation and dynamic association, respectively.

Since these two types were less described in the past, I intend to give a further discussion in this paper on the basis of some concrete examples.

The nine faults described in this paper are different in scale. The Mudangou fault extends to a length of several kilometers, the Tangyu and Lanqiao are respective parts of two deep faults, while the others are regional faults extending several tens of kilometers. In regard to their mechanical properties, these faults are chara-
characterized by compresso-shearing, except the Mudangou fault on which there is still some debate. Many problems are involved because fault zones generally have a long history of complex development (including changes in mechanical properties, etc.). Therefore, in this paper only a comparison is made of the composition of teconites with that of the original rocks as a guide to some common phenomena.

**Description of Some Examples of Dynamic Differentiation**

*Mudangou fault, Lintong, Shaanxi*

The Mudangou fault is located about 1 km west of Huaqingchi, Lintong, Shaanxi Province. The fault is developed in Tertiary red beds consisting of conglomerate feldspar-silicarenite intercalated with pelitic siltstone on the eastern side and of medium-fine silicarenite on the western side. The strata on both sides incline to the west with dip angles of $10^\circ$–$20^\circ$ (Fig. 1). On the eastern side, the fault scarp is made up of siliceous mylonite with a height of about twenty metres. Close to the fault scarp is the stratification-gap zone with a width from several to more than 10 meters. Further eastward, a normal zone is macroscopically recognized, consisting of sandstone beds, where the pelitic siltstone rapidly thins out westward and disappears in the siliceous mylonite, but thin-section examination shows that the sandstone has been subjected to dynamic effect. This section may be called an affected zone with a width of about 10 meters.

The normal sandstone is characterized by basement-cementation (samples collected from a location about 100 meters distant from the fault plane). In the affected zone the matrix as cement material in sample L-11 decreases and is of contact-cementation, in which some feldspars exhibit a perthitic structure (Photo I-1) and a few new grains of quartz appear and on feldspar edges replacement by fine crystals of quartz is evident (on the right of Photo I-1). In thin section L-12 the perthitic structure is more common in feldspars with clean rims, probably formed or due to secondary growth under stress. In places cement materials among quartz grains completely di-

![Fig. 1. Cross section of the Mudangou fault.](image)

1. Conglomerate feldspar-silicarenite; 2. pelitic siltstone; 3. medium-fine-grained silicarenite; 4. siliceous mylonite; 5 sample locality and sample number.