

Paleostress associated with the formation of well-oriented vein-type ores: the case of the Nagano area, southern Kyushu, Japan

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Crustal stress is one of the important factors that control fluid flow through the crust. Vein type ore deposits are the fossils of ancient fluid migrations through open fissures, thereby suggest the state of stress at the time of ore formation.

From this viewpoint, we studied with mesoscale faults in Plio-Pleistocene non-marine strata in the Nagano area, southern Kyushu, Japan, where vein-type ores were deposited at about 2 million years ago. Mesoscale faults are easily recognized in well-laminated sedimentary rocks. Next to the metallogenic area, we found some 200 faults in lake and fluvial fan deposits and andesitic volcanics. The lake deposit is underlain by volcanic rocks, which yielded K-Ar and fission track ages of about 1.9-2.3 Ma and 2.4 Ma, respectively (Hase and Danhara, 1985; MITI, 2000). K-Ar ages of about 1.8 Ma were obtained from the overlying andesitic volcanics (MITI, 2000). And, the veins were dated by the K-Ar method at 1.9 Ma. The accumulation of the sedimentary and volcanic packages and the deposition of the veins occurred one after another within several hundred thousands years around 2 Ma.

The fault-slip data from this area were subdivided into several groups according to the horizon of the strata from which the data were obtained. By means of the method of Sato (2006), we calculated stresses from the data from four stratigraphic units that yielded more than 25 data. Data from the lower and upper lake deposits showed the strike-slip fault regime of stress with N-S compression and NNE-SSW extension. The fluvial fan deposit which is younger than the lake deposit gave the strike-slip faulting regime of stress with WNW-ESE compression and NNE-SSW extension. Faults in the younger andesitic volcanics exhibited the normal faulting regime of stress with WNW-ESE extension. It should be noted that the topographic load of the volcano that was composed of this volcanics could disturbed the stress field in and around the volcano. That is, the normal faulting regime can not be regional but local stress.

The vein type ores in this area have E-W trends coherently (Matsutoya, 1967), suggesting a N-S trending σ_3 axis. This is consistent with the state of stress found from the fluvial fan deposit. That is, the ore deposited under the strike-slip faulting regime of stress with N-S extension. The different state of stress found from the older deposit also suggests that the state of stress changed just before the ore formation.

To the north of the Nagano area, plural stresses were reported from ca. 2.5 million-years-old deposits in the Hitoyoshi area, southern Kyushu (Yamaji, 2003). So, it is possible that the change in stress field occurred in southern Kyushu around 2 Ma.