Magnetic petrology of Unzen volcano, Japan: implications for lava dome oxidation processes

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Since the 1990-1995 eruption of Unzen volcano, Japan, non-explosive lava dome eruption has attracted many researchers' interests. In particular, to clarify the physical and chemical phenomena in lava dome have been demanded because block-and-ash flows, which are the most dangerous during eruption, are generated from collapse of lava dome. However, the quantitative understandings of generation mechanisms of block-and-ash flows have not advanced yet, although some models were proposed on the basis of visual observations of the lava dome just before generating a block-and-ash flow (Sato et al., 1992; Nakada and Fujii, 1993; Ui et al., 1999). This is not only because steep topography of lava domes prevents us from surveying and sampling at will but also because silicate minerals, which most petrologists use, do not record the conditions in the dome.

Iron-titanium oxide minerals are very useful for studying lava domes. They are oxidized in such circumstances as lava dome and transformed into composite multiphase grains whose phases have distinct chemical compositions. In addition, two solid solution series, titanomagnetite (Fe3-xTixO4) and titanohematite (Fe2-yTiyO3), show magnetic properties and acquire thermoremanent magnetization during cooling from above the Curie temperature (Tc) or Neel temperature, although the pseudobrookite series (Fe2-zTi1+zO5) are all paramagnetic. Their magnetic properties depend on compositions, grain sizes and amount of oxide minerals. Therefore, if we identify iron-titanium oxides and determine their properties, we can estimate the oxidation process of iron-titanium oxides during cooling in the lava dome. Such a method of study has been recently graced with a formal name Magnetic petrology (Wasilewski and Warner, 1988) and was introduced by Frost (1991b).

The 1990-1995 eruption of Unzen volcano was monitored and investigated in detail (e.g. Nakada et al., 1999). The growth of lava domes and the generation of block-and-ash flows were recorded. Therefore quantitative study with physical and chemical phenomena in the lava dome is possible. In this work, we carried out magnetic petrological analyses on samples from the lava dome and block-and-ash-flow deposits of the 1990-1995 eruption in order to examine the oxidation state and process in the lava dome. This is the first report about magnetic petrology of actual lava dome.