Geochemistry of Volcanic Rocks from Guryong Peninsula, Southeastern Part of Korea

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1. Introduction

In Guryong peninsula, located in the southeastern part of Korea, volcanic rocks are widely distributed and range from rhyolite, dacite, andesite, basaltic andesite to basalts. Among them, the mafic rocks are dominant. Yun et al., (1994) divided the Guryong mafic volcanics to Duilpo, Guryongpo andesites and Yeonil basalts. However, the chemical compositions provided by authors show that the Yeonil basalts actually are andesite and basaltic andesite. Our newest field observation and laboratory studies show that the mafic rocks from Guryong peninsula consist of andesite, basaltic andesite and basalts or sub-volcanic analogues (diabase, gabbro porphyrite). The andesite and basaltic andesite occur in lava flows, whereas the basalts (or sub-volcanic analogues) occur in single dykes.

This study is for geochemistry of mafic volcanic rocks and mafic dykes as well as their interpretations of the genesis.

2. Geological setting

The study area is composed of, in ascending order, Cretaceous sedimentary rocks named Balsandong Formation, granite, Eocene Duilpo andesite, Gangsari tuff, Gumanri rhyolite, acid to intermediate dykes, and Miocene Janggi conglomerate, Nudaeri tuff, Hudongri tuff, Gonggaesan dacite, Guryongpo andesite, Guryongpo rhyolite breccia, Yeonil basalt, Imgok Formation and alluvium.

The Balsandong Formation consists of arkose sandstone, reddish tuffaceous shale, well-layered black shale and gray shale from the bottom. The granite occurs as a stock shape and contains quartz, plagioclase, orthoclase, biotite and opaque oxide.

The Duilipo andesite is mainly darkish green in the outcrop. The rocks show porphyritic texture and contain plagioclases as phenocrysts. The Gangsari tuff consists of volcanic breccia, lapilli tuff, welded tuff and tuff showing mainly grayish white and partly brown and grey color. The Gumanri rhyolite is characterized by the flow texture. The dikes are porphyritic granite, feldspar porphyry and mafic dykes. The porphyritic granite contains quartz, orthoclase and plagioclase as phenoctyst and aphanitic groundmass.

Key words: Guryong peninsula, mafic volcanic rocks, mafic dykes, geochemistry

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The Janggi conglomerate consists of tuffaceous agglomerate, tuff breccia and welded tuff. The Nuldaeri tuff is fine to coarse-grained glassy tuff with grayish white pumice. The rocks partly contain tuffaceous mudstone and shale. The Hudongri tuff is flow tuff at low strata and fallout tuff at upper strata. The Gonggaesan dacite contains plagioclase, biotite, amphibole and quartz as a phenicryst and aphanitic as groundmass. The Guryongpo andesite shows faint green and blue color in outcrop. The Yeonil basalt intrudes the Gangsari tuff. In our studies, the Yeonil basalt will be included to the Guryongpo andesite group. The Guryongpo rhyolite breccia contains granite, shale, andesite and gneiss breccias with minor tuff breccia. The Imgok formation consists of the unconsolidated conglomerate, sandstone and shale with coal layer(2-30 cm).

The mafic volcanic rocks range from basalt to basaltic andesite and andesite. The andesite and basaltic andesite occur in lava flows. The lava flows widely distributed in the southern part of Guryong Peninsula, while in the northern part only a few single and small in size flows were observed along the coastline. Andesite and basaltic andesite consist of Duilpo and Guryongpo groups, distinguish by some petrographical features. However these rocks show similarity in major and trace element compositions and will be interpreted together. The mafic dykes have variable thickness and intruded in andesite lava, tuff breccia or granite.

3. Petrography of Guryong mafic volcanics rocks

Mafic volcanic rocks from Guryong Peninsula are lava flows and dykes intruded into different formation. The lava flows are composed of andesite and basaltic andesite.
Of the andesite and basaltic andesite, the lava of Duilpo group has moderately porphyritic texture containing only plagioclase in phenocrysts of about 5-10 vol%, and groundmass shows fluidal texture. All lavas from Guryongpo group display similar petrographic characteristics, having moderately porphyritic to porphyritic texture with phenocryst contents of about 15-45 vol%. Among the phenocrysts, plagioclase is dominated with minor amount of clinopyroxene and opaque minerals. Plagioclase lath of 1-2.5 mm in size, usually zoned and well twined. Plagioclase phenocrysts are labradorite and mostly are fresh, unaltered. Clinopyroxene phenocrysts are smaller in size (1-1.5 mm) and augite. The phenocrysts are set in microcrystalline groundmass, which consists of plagioclase, pyroxenes and titanomagnetite. Single phenocrysts of hornblende occur in some samples.

The mafic dykes are mostly composed by diabase or gabbro porphyrite. The rocks contain laths of plagioclase, ranging from 1 to 1.5 mm and usually resorbed. Texture is typical diabatic with clinopyroxene (and olivine) interstitial between plagioclase laths. In the sample from a dyke intruded into granite, the diabase was strongly altered. The rocks were deformed, crushed and plagioclase laths usually were broken and replied by sausurite.

4. Sampling and analytical methods

The fresh, unweathered samples for analysis were collected from lava flows and mafic dykes. Major element abundances were obtained on fused lithium tetraborate glass disks using a Rikagu RIX 2100 X-ray spectrometer at Center for Research Facilities, the Chungnam National University, Korea. Accuracies for the XRF analysis are ±5%. Trace elements concentrations were measured also at the Center for Research Facilities, using an ELAN 6000 ICP-MS and following the techniques provided by Eggins S.M. et al. (1997). For the ICP-MS method, about 20-30 mg of powdered samples were digested in mixtures of concentrated HF-HNO_3 (1:1) in 25-ml Teflon TFE screw-top vials by heating on hotplate for over 12 hours. After evaporation to dryness the samples were dissolved in 5 ml 4%-HNO_3 and heated on hot plate for over 3 hours. Finally, the samples were transferred to 200 ml ultra-pure water before analyses. The multiple standards, N930-0232, N930-0233, N930-0234 and N930-0235 (Perkin Elmer) were used for calibration. Sample preparation was conducted in a clean room and all acids used were ultra-pure. The precision and accuracy of the method are ±2% for the rare earth elements (REE) and ±3% for the other trace elements.

5. Conclusion and implication

Mafic volcanic rocks from Guryong Peninsula consist of lava flows and mafic dykes. The lava flows are composed of andesite and basaltic andesite, and dykes consist of basic sub-volcanic rocks as diabase or gabbro porphyrite. While both groups have medium K composition, the lavas belong to the cal-alkali suite, but mafic dykes belong to tholeiite suite. Andesite lavas have more variable contents of almost LILE and HFSE. Although there is no sign of systematic LILE enrichment, the andesite lavas have higher contents of some LILE (e.g. Ba, Rb and Sr) in comparison with mafic dykes. In contrast the variations of HFSE are more complicate. Andesite lavas are depleted in some HFSE such as Zr, Nb and have higher LILE/HFSE (e.g. Ba/Nb), but in contrast the mafic dykes are strongly depleted in Th. The LREE contents and LREE/HREE ratios are significantly higher in andesite lavas (e.g. La/Yb). While the effects of fractional crystallization have been clear recognized, the effects of crustal contamination are limited. Most of the mafic volcanic rocks lie in the arc volcanic field and fell into the overlapped field of continental island-arc and other oceanic-arc. Despite the differences between the two groups, there are many similarities between them, suggesting a genetically relation and the mafic volcanic rocks from Guryong peninsula may be generated by partial melting of the inhered subduction and evolved mainly by fractional crystallization rather than crustal contamination.