PETROGENSIS OF HED METEORITES AND IMPLICATIONS FOR MAGMATIC EVOLUTION OF PARENT BODY

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Introduction: The Howardite—Eucrite—Diogenite (HED) clan of meteorites are ultramafic and mafic igneous rocks, which is the largest quantity of magmatic meteorites available on the earth[1], providing an unmatched significance for studying the early magmatic evolution processes of the asteroids[2]. In this paper, nine different types of HED meteorites, including orthopyroxenite (NWA 7831 and Tatahouine), gabbro (NWA 11599 and NWA 11600), diabase (Tirhert), basalt (NWA 11602 and NWA 11603) and breccia (GRV 13001 and NWA 11598) were selected for systemic lithological observation and geochemistry analysis. Our studies are mainly concentrated on the structure and texture of rocks, major and trace elements geochemical characteristics in terms of whole rocks as well as minerals. Based on these new data, we have made some significant achievements regarding to the HED clan of meteorites petrogenesis, implication of magmatic evolution and thermal metamorphism.

Petrology and Mineralogical Chemistry: The HED meteorites are mainly composed by orthopyroxene, clinopyroxene, plagioclase, and minor quartz, spinel, iron, troilite, ilmenite and so on. These meteorites show a typical cumulated, gabbro, ophitic and basaltic texture from orthopyroxenite to basalt respectively. Generally, pyroxenes in orthopyroxenite are bronzite-hyersthene with generalized compositions of $Fs_{19.2\sim30.6}Wo_{1.43\sim5.00}$, while in cumulate gabbros mostly are hypersthenes with generalized compositions of $Fs_{34.1\sim37.9}Wo_{1.88\sim3.24}$ and minor augite—diopside exsolution lamella with generalized compositions of $Fs_{14.0\sim16.0}Wo_{41.3\sim46.5}$. The majority of pyroxenes in basalt are pigeonites with generalized compositions of $Fs_{44.1\sim65.3}Wo_{5.11\sim22.3}$, but slightly augite exsolution lamella with generalized compositions of $Fs_{26.1\sim47.7}Wo_{26.4\sim45.0}$ and ferro-hypersthenes with generalized compositions of $Fs_{57.8\sim62.9}Wo_{1.83\sim4.96}$. Mostly plagioclases found in the HED clan of meteorites are anorthites with generalized compositions of $An_{90.0\sim97.4}Ab_{2.20\sim9.73}$, and a small amount of bytownites and labradorites, with generalized composition of $An_{87.7\sim89.7}$ $Ab_{10.0\sim11.3}$ and $An_{73.2\sim77.9}$ $Ab_{20.8\sim24.4}$, respectively.

Result and Discuss: （1）The $Mg^{\#}$ value of pyroxene has been used extensively in identifying rock type and elucidating evolution process of magmas of HED family meteorites. Pyroxenes from orthopyroxenite, cumulate gabbro and basalts have distinctive $Mg^{\#}$ values. More specifically, the enstenite from the orthopyroxenite, cumulate gabbro and basalts have decreasing $Mg^{\#}$'s of 72.8, 63.5 and 36.6, respectively. Similarly, the clinopyroxene from these rocks yielded $Mg^{\#}$'s of 71.4, 73.9 and 44.7, respectively.（2）The whole—rock composition of the HED clan of meteorites indicates that the total amount of rare earth elements (REE), the ratio of LREE/HREE, the lithophile and incompatible trace elements are increasing from orthopyroxene through to cumulate gabbro and then to basalt. On the other hand, based on those pyroxene REE and incompatible trace elements results, we inferred that the accumulated pyroxenite and gabbro are the products of magma crystallization differentiation. In contrast, the fomation process of the basalt is much more complicated. Most of them are formed by the crystallization of residual magma[3], whilst a few of them derived from non-equilibrium crystallization of magma partial melting.（3）Crystallization sequence of the HED clan are accumulated pyroxenite, gabbro, diabase and basalt, which are characterized by homology and inheritance in magmatic evolution. These meteorites are formed from deep to shallow, corresponding to high temperature to low temperature as well as low thermal metamorphism to high thermal metamorphism. The thermal metamorphism of the superficial basalt can be caused by the heating of the multi-stage eruption of the basaltic magma[4].

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