DIFFERENT FORMATION PROCESSES OF THE MOON, THE EARTH, AND METEORITES; Y. Miura, Department of Mineralogical Sciences and Geology, Faculty of Science, Yamaguchi University, Yamaguchi 753 Japan.

Different formation processes of the Moon, the Earth and various meteorites are summarized as follows[1-4]:

Origin of the Moon: Major four hypotheses – giant impact, co-accretion, capture and fission are schematically drawn in Fig. 1, where the Earth is centered and cosmic (traffic) accident of impact event should be emphasized by more detailed dynamic process [5].

Formation process of the Moon: Chemically homogeneous melt state in the primitual planets can be well explained as proposed melt (magma) ocean resulted in an initial differentiation. The compositional deficiency from An100 to An97 (mole%) might be caused by existence of initial melt (magma) ocean, especially compared with that in chondritic meteorites [3]. After formation of layered structure by the melt ocean, the cooling of the lunar surface could be also produced by intense, numerous and periodic bombadements of cooled extra-lunar materials. Heterogeneous cooling process is observed in various An contents (96 mole% in 15415,89 and 76535,54; 94 mole% in 65015,95 and 67435,74) and mg values with vertical trends (by quenching from initial differentiation) and oblique trends (by impact mixing and recrystallization) in An-mg diagram [2] before 4.2 b.y. period. Heavy intense bombardment and recrystallization period around 4.0 b.y. could be supported by the most complex lunar samples of ferroan anorthosite (15415,89), breccias (73215,236; 77515,12; 14321,133; 14066,50; 15455,196), and KREEPy rocks (63555,49; 68415,133; 75055,47; 14310,23/110). The exotic rock in Apollo-14 and -16 samples would be formed in such complex mixing periods of impact mixing, crystallization and assimilation. Mainly temperature-dependent crystallized rocks are found in mare basalts (10003,152; 10062,71; 12002,160; 15555,207) with different chemical and cooling processes. The dry and vacuum condition of the Moon stops further crystallizing the initial rocks, resulted in the lowest mean value of An77 (e.g. 14066,50) (Figs. 2 and 3).

Formation process of the Earth: The similar compositional gap of An100-97 in the oldest Fiskenaesset type anorthosite would support of initial melt (magma) ocean period in the Earth. The longer period of the magma melt ocean periods is simply explained by the volume difference between the Moon and the Earth; that is 16 times longer melt periods, as shown in Fig. 4. The wet and oxidized condition of the Earth produced multi-stage crystallized rocks, and albite plagioclases up to An0 composition by various temperature and pressure conditions.

Formation processes of meteorites: Several meteoroids are referred to presolar nebula (in E, H, L, LL, C chondrites) and asteroids (in achondrites) [3]. An-mg relation of the chondrites suggests that E3 chondrites would be formed at relatively higher impact-pressure with rapid-cooling condition, such as center of the pre-solar nebula and region closed to the disk plane. The LL3 chondrites would be formed at temperature-dependent slow-cooled condition, such as margin of the pre-solar nebula and area of far-distance from the disk plane. Accretion process of the meteorites but with dry and vacuum conditions would produce the major An10...
albite plagioclase compositions.

REFERENCES:

Fig. 1. Four hypotheses of the origin of the Moon [5].

Fig. 2. Formation process of the moon.

Fig. 3. Comparative difference of formation process among the Moon, the Earth and meteorites in An - mg diagram.

Fig. 4. Comparative difference of formation process with time among the Moon, the Earth and various meteorites.

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