26Al ages of ferromagnesian chondrules of CO3.0 Yamato-81020

Erika Kurahashi[1]; Noriko, T. Kita[2]; Hiroko Nagahara[3]; Yuichi Morishita[4]

[1] Earth and Planetary Sci. Univ. of Tokyo,

GSJ; [2] GSJ, AIST; [3] Dept. Earth Planet. Sci., Univ. Tokyo; [4] Geological Survey of Japan, AIST

Chronometer using the short-lived extinct-nuclide 26Al has been applied to chondrules in order to obtain their formation ages. Previous studies were mostly performed on Al-rich chondrules, which constitute only 1% of all chondrules, because of their high Al/Mg ratios. Recently, 26Al ages of major ferromagnesian chondrules in least equilibrated ordinary chondrites (OC) have been broadly obtained [1-3]. However, those of ferromagnesian chondrules in least equilibrated carbonaceous chondrites (CC) are very limited [4-6]. Particularly, age data of FeO-poor (Type I) chondrules in CC are scarce. In order to clarify the origin and formation processes of chondrules, we have started systematic investigations on Type I chondrules in the most pristine CC (CO3.0 Yamato-81020) [7-9], by examining textures, bulk chemical compositions, 26Al ages and oxygen isotopic compositions. We find Type I chondrules in CC formed contemporaneously with ferromagnesian chondrules in OC.

The Al-Mg isotopic analysis was performed using a secondary ion mass spectrometer (SIMS) Cameca IMS-1270 at the Geological Survey of Japan (GSJ). In order to detect a small 26Mg-excess with a few permil levels, most analyses for anorthite took 4-6 hours per position. Petrographic observation of individual chondrules was carried out using an optical microscope and an electron microprobe (EPMA). Bulk chemical compositions of the chondrules were obtained using EPMA by averaging about 500 points per chondrule. More detailed analytical technique is shown in [10].

All Type I chondrules consist of forsteritic olivine (Fo91-100), low-Ca pyroxene with anorthite (An84-100) and high-Ca pyroxene in mesostasis, associated with various amounts of rounded to irregular Fe-Ni metal and/or FeS grains. Y1 is a barred olivine chondrule. Y2, Y3, Y10 are very close to anorthite-rich chondrules in CR chondrites [11], which have anorthite-rich mesostasis at the center containing small forsteritic olivine grains. Y23, Al-rich chondrule (Al2O3 23.6wt%), mainly consists of high-Ca pyroxene and anorthite (An99) with small euhedral forsteritic olivine (Fo97-99) grains.

We examined eleven Type I chondrules and one Al-rich chondrule for Al-Mg isotopic analysis. The initial 26Al/27Al, (26Al/27Al)0, of the chondrules fall in the range between (5.1+/-2.2)x10^-6 and (1.4+/-0.3)x10^-5 for Type I chondrules and (3.1+/-1.4)x10^-6 for the Al-rich chondrule. Assuming that 26Al was homogeneously distributed in the early solar system, formation ages of the chondrules after CAIs are calculated with the canonical 26Al/27Al ratio of 5x10^-5 [12] to be 1 to 2.5 Myr for Type I chondrules and ~3 Myr for the Al-rich chondrule. It should be noted that the range of 26Al ages is almost the same as those of ferromagnesian chondrules in the least equilibrated OC that is 1-2.5Myr [1-3]. Thus, Type I chondrules in CC formed contemporaneously with ferromagnesian chondrules in OC. We do not observe any correlation among ages of Type I chondrules and their texture or composition, such as mineral assemblages, size distribution, bulk chemical composition, and abundance of metal grains. This suggests that chondrule formation occurred by random sampling of their precursors during 1-2.5Myr after CAIs formation in the Type I CC chondrule forming region.

References:[1] Kita et al. (2000) GCA, 64, 22, 3913-3922. [2] McKeegan et al. (2000) LPS XXXI, #2009. [3] Mostefaoui et al. (2002) M&PS, 37, 421-438. [4] Yurimoto and Wasson (2002) GCA, 66, 24, 4355-4363. [5] Kunihiro et al. (2003) LPS XXXIV, #2124. [6] Hsu et al. (2003) M&PS, 38, 35-48. [7] Kojima et al. (1995) Proc. NIPR Symp. Antarct. Meteorites, 8, 79-96. [8] Shibata (1995) 20th Sym. on NIPR Antarctic Meteorites, 228-229. [9] Shibata (1996) Proc. NIPR Symp. Antarct. Meteorites, 9, 79-96. [10] Tachibana et al., (2003) M&PS, 38, 939-962. [11] Krot and Keil (2002) M&PS, 37, 91-111. [12] MacPherson et al. (1995) Meteoritics, 30, 365-386.