Chronology of early solar system inferred from precise Al-Mg isotope systematics of Vigarano CAIs

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Calcium, Aluminium-rich Inclusions (CAIs) are the oldest solar system solids that have been absolutely dated to have an age of ~4.57 Ga [1-2]. High precision *in situ* Al-Mg isotope systematics studies of CAIs, and other early formed solar system objects, using secondary ion mass spectrometer (SIMS) provides an opportunity to obtain very precisely time of last melting event (from $^{26}Al/^{27}Al$ ratio) and Mg isotope composition at this time (from $\delta^{26}Mg_0$) [3-6]. This allows better understanding of high temperature events in the solar accretion disk by constraining their durations with greater precision (~10^5 years), the components involved (gas or solids) and the history of these components. Eight CAIs of different types from one of the least altered meteorite Vigarano ($CV_{reduced}$ 3.1-3.4) were analysed for Al-Mg isotopic composition in order to answer several first order questions: (i) did condensation/melting of CAI precursors happen only during a unique single event in the accretion disk, (ii) how many high temperature events did CAI undergo, (iii) whether some of these events were related with chondrule formation? In addition, it provides arguments for quantifying the level of homogeneity of Al, and Mg isotopes in the inner solar system [3, 7]. Results obtained so far suggest melting of CAIs at different periods of time from precursors extracted earlier, in a short time interval, from the solar gas. No indication of ^{26}Al heterogeneity has been found.

[1] Bouvier & Wadhwa (2010) *Nature geo.* **3**, 637–641. [2] Amelin *et al.* (2010) *EPSL* **300**, 343–350. [3] Villeneuve *et al.* (2009) *Science* **325**, 985–8. [4] Kita *et al.* (2010) *LPSC 41* 2154. [5] Davis *et al.* (2010) *LPSC 41* 2496. [6] MacPherson *et al.* (2010) *ApJ* **711**, L117-121. [7] Jacobsen *et al.* (2008) *EPSL* **272**, 353–364.

Formation of the nitrogen B-aggregates in type Ib diamond

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Most of natural diamonds contain nitrogen atoms more or less and they form many types of aggregates by annealing. When the diamonds contain nitrogen atoms in single substitutional form, in substitutional nitrogen pairs (named A-centers) or in B-aggregate form, they called type Ib, type IaA or type IaB, respectively. As many natural diamonds are their mixed types and contain impurity atoms in reality, all types of diamonds must be obtained artificially for investigation. However to form the nitrogen B-aggregates consist of four substitutional nitrogen atoms surrounding a vacancy from isolated nitrogen atoms of type Ib diamond the samples must be annealed for an extraordinary long time under high temperature and high pressure conditions. Therefore it was thought till recently that to form the B-aggregates artificially is preposterously difficult and a diamond which contains the B-aggregates is natural. Collins [1] observed formation of the A-centers in the electron irradiated and annealed type Ib diamond and thought that the aggregation of nitrogen is enhanced by vacancies introduced due to the electron irradiation. However this treatment was not enough powerful for generating big nitrogen aggregates like the B-aggregate.

We studied the neutron irradiation effects on the nitrogen aggregation in type Ib diamonds. The nitrogen concenteration of samples were ranged from 50 to 340 ppm and the neutron irradiation was carried out with doses of 1.1×10^{16} n/cm^2 to 2.8×10^{18} n/cm^2. The samples were annealed at various temperatures between 1000 to 1700 centigrade degrees for several annealing times under a pressure of 6 GPa. It was observed that the aggregation due to the high temperature and high pressure annealing is highly accelarated by vacancies introduced through the neutron irradiation and a large amount of B-aggregate was generated from single nitrogen. The best record of generation time of B-aggregates at present is shorter than 30 minutes.

[1] Collins (1980) *J. Phys. C, Solid St. Phys.* **13** 2641–2650.