Why are there so few presolar grains in samples from comet Wild 2?

F.J. STADERMANN[1]*, C. FLOSS[1], A.T. KEARSLEY[2], AND M.J. BURCHELL[3]

[1]Physics Dept., Washington Univ., St. Louis, MO 63130, USA (*correspondence: fjs@wustl.edu, floss@wustl.edu)
[2]Dept. of Mineralogy, Natural History Museum, London SW7 5BD, United Kingdom (a.kearsley@nhm.ac.uk)
[3]School of Physical Sciences, University of Kent, Canterbury CT2 7NH, United Kingdom (M.J.Burchell@kent.ac.uk)

When the solar system formed some 4.6 Ga ago, it incorporated presolar grains that had condensed around other stars and that escaped the widespread homogenization in the solar nebula. Such grains are still present at ppm-levels in various types of solar system materials and can be identified on the basis of their anomalous isotopic compositions, which reflect their stellar formation conditions. Since presolar grains can easily be destroyed by a variety of parent body alteration processes, relatively high abundances of such grains can attest to the primitive nature of its host material (e.g., interplanetary dust particles, primitive meteorites).

Among the most perplexing results of the analysis of Wild 2 cometary matter, which was returned by the Stardust probe [1], is the fact that it contains large contributions of high-temperature minerals [1, 2], but only very few presolar grains [3-9]. Both observations are in apparent conflict with the expectations for this comet whose residence in the cold Kuiper belt should have provided ideal conditions for the preservation of primitive early solar system materials.

To evaluate whether the low abundance of presolar grains in Wild 2 material could be due to preferential destruction of such matter during sample collection, we are now performing 6.1 km/s test shots of pulverized meteoritic material with known presolar grain abundances into Stardust analog collector foils [9]. Early results indicate that there may indeed be a larger loss of such grains than previously thought, but it remains to be seen whether this can fully account for the observed low abundance. Alternatively, the low abundance may be due to a significant dilution with material from the inner solar system [5]. Various scenarios will be discussed.

[1] Brownlee *et al.* (2006) *Science* **314**, 1711. [2] Zolensky *et al.* (2006) *Science* **314**, 1735. [3] McKeegan *et al.* (2006) *Science* **314**, 1724. [4] Stadermann *et al.* (2008) *MAPS* **43**, 299. [5] Stadermann & Floss (2008) *LPSC* **39**, abstr. #1889. [6] Messenger *et al.* (2009) *LPSC* **40**, abstr. #1790. [7] Brownlee *et al.* (2009) *LPSC* **40**, abstr. #2195. [8] Leitner *et al.* (2009) *LPSC* **40**, abstr. #1512. [9] Stadermann *et al.* (2009) *LPSC* **40**, abstr. #1188.

The carbon/carbonate equilibria in the Earth's mantle as function of pressure, temperature and oxygen fugacity

V. STAGNO* AND D.J. FROST

Bayerisches Geoinstitut, Universität Bayreuth, D-95440, Germany
(*correspondence: vincenzo.stagno@uni-bayreuth.de)

The speciation of carbon in the mantle will be controlled to a large extent by the oxygen fugacity. Under relatively oxidised conditions carbonate- bearing minerals and melts (carbonatites and kimberlites) will be stable, while under more reduced conditions diamond, graphite or CH_4 may form. The aim of this study is to determine the oxygen fugacity buffered by equilibria involving carbon (graphite/diamond) and carbonate (minerals and melts) within typical mantle bulk compositions. In addition we have examined the effect on the oxygen fugacity of such equilibria as carbonate- bearing melts evolve towards more SiO_2-rich compositions at higher temperature. Experiments have been performed in the system Fe-Ca-Mg-Si-C-O at pressures from 3 to 25 GPa and temperatures from 1200-1600°C. Oxygen fugacities are measured using an Ir-Fe alloy as a sliding redox sensor.

There is evidence from mantle xenoliths that the effect of pressure on ferric/ferrous equilibria involving major mantle minerals drives the oxygen fugacity of the mantle down with increasing depth. By comparing our measurements of the oxygen fugacity of carbon/carbonate equilibria with the expected oxygen fugacity of the mantle, we can determine carbon speciation in the mantle. In up welling mantle the relative oxygen fugacity of peridotitic rocks should increase with decreasing depth. In this scenario the onset of carbonatitic melting in up-welling mantle will be controlled by the point where the ambient oxygen fugacity crosses the oxygen fugacity imposed by the appropriate carbon-carbonate equilibria, rather than the solidus of carbonate-bearing mantle. In addition, we have examined the effect on the oxygen fugacity of carbon/carbonate equilibria when other plausible components such as P_2O_5, FeS and Cl dissolve in carbonate melt.

Our results imply that: (1) the effect of melt composition on the carbon/carbonate fO_2 is relatively modest and up welling mantle will only cross from the graphite to the carbonate melt stability field at pressures below approximately 4 GPa; (2) deep (>100 km) carbonate rich melts are only stable in regions with an unusually high $Fe^{3+}/\Sigma Fe$ ratio, although P_2O_5 and Cl may also help to stabilize carbonate liquids; (3) the effect of pressure on the carbon/carbonate equilibria indicates that the bulk of the lower mantle might be in the carbonate stability field.