

The dissolution of hydrogen and carbon in reduced silicate melt

A. KADIK¹, F. PINEAU², YU. LITVIN³ AND M. JAVOY²

¹V.I. Vernadsky Institute of Geochemistry and Analytical Chemistry, RAS, Kosygin St. 19, Moscow 117975, Russia (kadik@geokhi.ru).

²Laboratoire de Geochimie des Isotopes Stables Universite Paris 7, IGP, 2 Place Jussieu, 75 251 Paris Cedex 05, France (fpi@ccr.jussieu.fr)

³Institute of Experimental Mineralogy, RAS, Chernogolovka, Moscow distr. 142432, Russia (litvin@iem.ac.ru)

The transport of volatile constituents from planetary interiors to surfaces provides the primary supply of material for the upper layers of the Earth and atmospheres. The major factor controlling that transport is the solubility of volatile species in magmas and the oxido-reduction evolution of the magma relative to their mantle sources. The iron-bearing silicate melt (ferrobasalt) + iron metallic phase + graphite + hydrogen equilibrium have been considered in this study to demonstrate that the carbon and hydrogen solubility in melt may have important implication for formation of volatiles in terrestrial magmas. The experimental conditions (3.7GPa, 1520 -1600°C) and hydrogen and oxygen fugacities ($\Delta \log f_{O_2}$ (IW) = -2.32±0.06), correspond to the reduction of part of the FeO which release oxygen in the silicate liquid. The speciation of the C- and H- components in quench glasses has been made using Infrared and Raman spectroscopy techniques. The water concentration has been obtained by ion microprobe and by stepwise heating extraction. The last technique gave also the carbon content. It has been established that the liberated oxygen was consumed mainly to oxidized hydrogen into OH, and to much lesser extent H₂O. Only traces of CO₂ and CO₃²⁻ were formed. Dissolved carbon is mainly present as atomic carbon or amorphous carbon. The spectrum also suggested that the network units contain Si-C bonds. The amounts of C and H dissolved in melts are particularly low. Carbon solubility remains about one order of magnitude less than that of water (about 2 wt% H₂O and 0.2 wt% C). In the light of experimental data it appears that a large scale melting of terrestrial matter (an early magma ocean) is certainly associated with the formation of melts containing oxidised forms of hydrogen, albeit the early Earth was likely a reducing environment. At the same time, it was found that the relative proportion of reduced carbon, CO₂ and CO₃²⁻ ion, in a silicate liquid, was essentially dependent on f_{O_2} .

A wiggle-matching technique applied to the dating of damaged cave deposits and compilation of a long-term paleoseismic record, Soreq Cave, Israel

E.J. KAGAN^{1,2}; M. BAR-MATTHEWS²; A. AYALON²; AND A. AGNON¹

¹Institute of Earth Sciences, The Hebrew University, Jerusalem (elisak@pob.huji.ac.il; amotz@cc.huji.ac.il)

²Geological Survey of Israel, 30 Malkhe Israel St., Jerusalem (matthews@mail.gsi.gov.il; ayalon@mail.gsi.gov.il)

An innovative wiggle-matching dating technique is applied to a paleoseismic study performed in two caves near Jerusalem, Israel. Among them, the Soreq Cave has been intensely dated using U-Th TIMS method and shows continuous cave deposit (speleothem) growth for at least 185 kyr. High-resolution composite $\delta^{18}O$ and $\delta^{13}C$ profile was prepared for paleoclimate research (Bar-Matthews et al., 2000; Ayalon et al., 2002). Research of past earthquakes, typically retrieving records from soft sediment deformations, can benefit from the study of rockfalls and damaged speleothems. Dating of collapses and the speleothems overgrowing them constrain the dates of earthquakes. The caves, located 60 km west of the Dead Sea Transform (DST), record earthquake damage associated with DST earthquakes and, possibly, smaller local intraplate events.

One of the difficulties in accurately dating paleo-earthquakes using U-Th methods is the relatively large amount of calcite needed, which distances the sample material from the tectonic contact, and causes the age to be an average of many years of growth. In addition, to avoid contamination from the collapse there is a need to extract material at some distance from the contact (the boundary between collapse and regrowth).

In order to obtain an age as close as possible to the age of the tectonic event we first estimate the age by U-Th dating of the laminae on both sides of the contact. We then compared the high-resolution $\delta^{18}O$ and $\delta^{13}C$ profile for each collapse sample with the densely-dated $\delta^{18}O$ and $\delta^{13}C$ profiles of the Soreq Cave. The isotopic data point, 0.5 mm from the contact, enables us to accurately date the event.

Thirty-nine collapses were dated, of which at least 15 separate events were identified. Of the Holocene events, all correlate with archeologically and geologically recorded earthquakes. Of the 6 events between 70-20 ka, 5 correlate with lacustrine seismites in the Lisan Formation (paleo-Dead Sea). Events older than 70 ka are, at present, the only paleoseismic record of its age studied in the region.

References

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