MICRODISTRIBUTION AND CORRELATION OF TRACE ELEMENTS IN MINERAL GRAINS OF SEMARKONA (LL3.0) AND DHAJALA (H3.8) AS DETERMINED BY PIXE ANALYSIS; **S. Bajt, E. Pernicka**, Max Planck Institut für Kernphysik, Postfach 103980, D-69 HEIDELBERG-1, West Germany
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The Heidelberg proton microprobe (PIXE) was used to determine the microdistribution of trace elements in olivines of the unequilibrated chondrites Semarkona (LL3.0) and Dhajala (H3.8). Olivine is regarded as one of the first condensation product in the solar nebula (1). Some of these original olivine grains may have survived relatively unaltered in unequilibrated ordinary chondrites and thus yield information on ambient conditions in the solar nebula (2).

This investigation concentrates on the distributions of trace elements in relatively large grains $> 30\ \mu m$. For the measurements specially prepared ultra thin polished sections were used. The distributions on a micrometer scale of elements like Ca, Sc, Ti, V, Cr, Mn, Fe, Ni and Zn, were determined. The experimental conditions were chosen in such a way to detect all these elements in the same measurement instead of optimizing for the detection of a single element. Nevertheless detection limits ranged from 10 to 100 ppm.

Especially one irregularly shaped forsterite grain with a size of about 900 x 500 μm was investigated in detail by step scans over the whole grain (3). The measured concentration profiles of different elements could be clearly diveded into two types (Fig.1). The first type, where the maximum concentration is typically at the edge of the crystal, is represented by Ca, Ti, V and Cr. The second type shows the maximum concentrations at about 100 μm distance from the grain surface and is represented by Mn, Fe and Ni. There is also a positive correlation between the position of the maximum concentration for an element from the surface and its diffusion coefficient, i.e. the higher the diffusion coefficient the larger is the distance of the maximum concentration from the grain surface.

Different distribution patterns were observed in olivine grains embedded in chondrules. Almost all of them are zoned, those near the chondrule's surface show stronger zoning than the ones in the interior. Sometimes different olivine grains in the same chondrule show opposite trace element zoning.

The observed distribution of trace elements in the isolated forsterite grain could be reproduced with a simple model based only on solid state diffusion. The assumptions were very fast rise of the ambient temperature with a following linear fall. It was also assumed that initially the gas phase concentration of the analyzed elements increased due to evaporation of solid material and gradually decreased parallel to temperature. The comparison between measurements and calculations from this model allows an estimate of a maximum temperature of 1100 to 1800 K. The corresponding times in which diffusion process took place were estimated to be 1000 and 3.5 years.

Experimental evidence shows that chondrules survive heating to about 1600 K for only a few minutes (4) contradicting the above upper temperature limit. This shows necessity for more sophisticated boundary conditions for the model, separating fast and slow processes and including the crystal growth, for additional experimental data and for precisely determined diffusion ceofficients for more elements.

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A more precise estimation of the maximum temperature experienced by isolated olivine grain is expected from further measurements and improvement of the model calculation. In addition, it may eventually be possible to derive diffusion coefficients of several elements in olivine, which have not been determined so far.

References:

(1) Larimer J. W., Anders E. (1967) *Geochim. Cosmochim. Acta* 31 pp. 1239-1270.
(2) Steele J. M. (1986) *Geochim. Cosmochim. Acta* 50 pp. 1379-1395.
(3) Bajt S., Pernicka E. and Traxel K., to be published in *Meteoritics* 24.
(4) Tsuchiyama A., Nagahara H. and Kushiro I. (1980) *Earth. Planet. Sci. Lett.* 48 pp. 155-165.

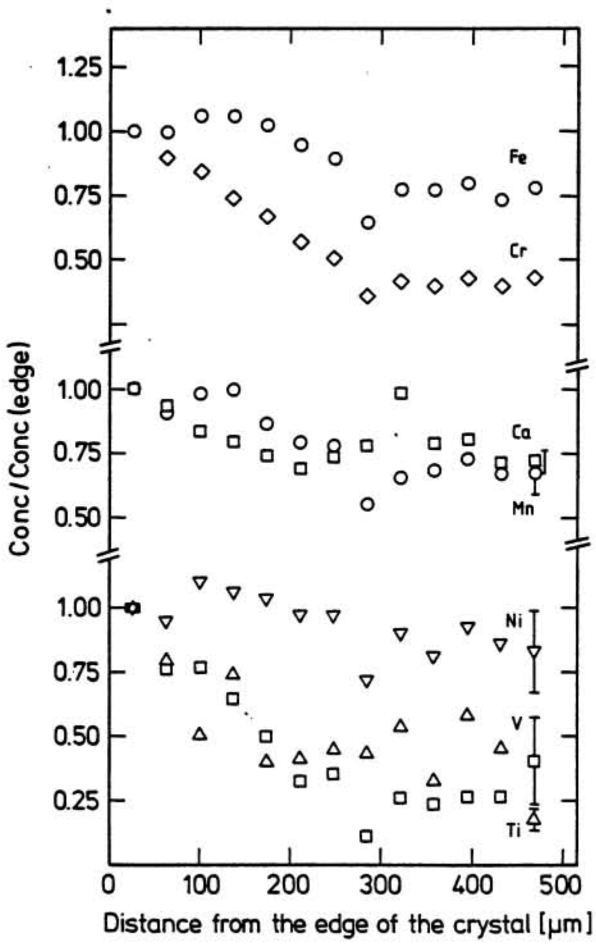

Fig. 1: Concentrations of elements as a function of distance from the grain surface normalized to the surface concentrations. These are: Fe 6.72 %, Cr 3375 ppm, Ca 1270 ppm, Mn 930 ppm, Ni 130 ppm, V 95 ppm and Ti 115 ppm. The elements Mn, Fe and Ni show the maximum concentration about 100 μm away from the surface.