Short scientific report
on usage of 2nd Eurominsci Conference Travel grant

by Olga Narygina
PhD student in Bayerisches Geoinstitute, Universität Bayreuth, Germany
Supervisor: Dr. Leonid Dubrovinsky
ESF Unit: LESC
EUROCORES Programme Title: EuroMinSci
EUROCORES Programme Acronym: MCEC

I used the 2nd Eurominsci Conference Travel grant to cover expenses on participation in AGU Fall Meeting 2008. The conference was held in San Francisco, California, USA, on 15-19 December, 2008.

This annual conference is known to be one of the most important geophysical meetings of a year. I am very thankful to ESF EuroMinSci program for giving me the opportunity to take part in this meeting, to present my work there and to get the very useful feedback from outstanding scientists from all over the world.

At the conference I presented the poster with my recent experimental results on investigation of Fe-Ni-C system at elevated pressures and temperatures. This work was done in the frame of EUROCORES project “Mineralogy and Chemistry of Earth's core”. The abstract of my presentation is presented below as well as the copy of poster.

Abstract of the poster presentation at AGU Fall meeting 2008
Section: Study of Earth’s Deep Interior
Special Session: The Ins and Outs of the Earth’s Core

Fe-Ni-C system at high pressure

Olga Narygina¹, Leonid Dubrovinsky¹, Catherine McCammon¹, Dan Frost¹, Nobuyoshi Miyajima¹, Vitaly Prakapenka².

¹Bayerisches Geoinstitut (BGI), Germany, ²Advanced Photon Source (APS), USA.
Apart from being technologically important, FeNi alloys introduce particularly interest to the material sciences as well as to the geosciences. It is generally accepted that the Earth’s core is predominantly composed by FeNi alloy with 10-15 wt% Ni. The certain amount of the light element(s) is also known to be presented in the Core. A number of candidates for the light component have been proposed, including sulphur, oxygen, hydrogen and carbon. In favor of the last one the following arguments can be listed (i) high cosmic abundance, (ii) chemical affinity to iron even at low pressures and (iii) capability of lowering the density of molten iron. Although there is quite a bit of experimental and theoretical results on high pressure high temperature behavior of the system Fe-C, there is still lack of information about the phase relations in Fe-Ni-C system at elevated pressures and temperatures.

Therefore we provided a series of compression experiments on the system Fe-Ni-C at pressures up to 53 GPa in temperature range 300 - 2600 K (combining diamond anvil cell and large volume press techniques) in order to investigate phase diagram of Fe-Ni system and the influence of carbon on the phase relations in the system at elevated pressures and temperatures.

We observed that dissolution of even 1 wt% carbon in FeNi alloys with 10, 15 and 22 wt% Ni leads to dramatic changes in the system: presence of carbon stabilizes $fcc$-structured FeNi through the redistribution of nickel. Combining Mössbauer spectroscopy, XRD, TEM and chemical analyses by microprobe and SEM techniques we detected the formation of Ni-poor and Ni-enriched phases, with different elastic and structural properties.

Acknowledgments

This presentation is supported by the European Science Foundation (ESF) under the EUROCORES Programme MCEC through contract No. ERAS-CT-2003-980409 of the European Commission, DG Research, FP6
The Earth’s core is believed to be composed of Fe-Ni alloy with a certain amount of the light element(s). A number of candidates for the light components have been proposed, but the most plausible are sulphur, oxygen, hydrogen and carbon. In favor of carbon the following arguments can be listed: (i) high cosmic abundance, (ii) chemical affinity to iron even at low pressures and (iii) capability of lowering the density of molten iron. Although there is quite a bit of experimental and theoretical results on the behavior of Fe-Ni alloys at elevated pressures and temperatures, there is still lack of information about the influence of carbon on the phase relations in this system under extreme conditions.

In order to investigate the effect of carbon on Fe-Ni phase diagram we provided a number of compression experiments on the Fe-Ni and Fe-Ni-C systems at pressures up to 53 GPa in the temperature range 300 - 2600 K (combining diamond anvil cell (DAC) and large volume press (LVP) techniques).

We performed a series of LVP runs with homogeneous Fe-Ni-C powder mixtures of different stoichiometry (Fe_{0.9}Ni_{0.05}C_{0.05} 0.01 ≤ x ≤ 0.05) at pressures 0.5 - 20 GPa and temperatures 2010 - 2300 K.

Conclusions:

- The solubility of carbon in Fe-Ni alloy increases with pressure and can reach value of 4 wt% (at 20 GPa) without formation of Fe_3C carbide.
- Carbon has a significant effect on the phase relations in Fe-Ni system:
  1. It decreases melting temperature of Fe-Ni alloys for several hundreds of degrees.
  2. At high pressure presence of even 1 wt% carbon in Fe-Ni system leads to formation of non-magnetic fcc-based phase (fcc*).
  3. Amount of these fcc* phase is proportional to the amount of dissolved carbon.