	Experiment title: In situ kinetics of Antigorite Dehydration	**Experiment number**: HS 2131
Beamline: ID30	**Date of experiment**: from: 23/07/2003 to: 28/07/2003	**Date of report**:
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Report:

The dehydration of serpentine minerals (i.e. phyllosilicate minerals resulting from the hydrothermal alteration of mantle rocks in oceanic basins and margins) during the subduction of oceanic lithosphere may cause partial melting in the overlying mantle, thus giving rise to arc volcanism (Hattori & Guillot, 2003). This dehydration reaction has also been proposed to explain intermediate focus (60-120 km) earthquakes in subduction zones, since dehydration may produce embrittlement or frictional sliding in rocks (Peacock, 2001). Antigorite is the only serpentine mineral stable at mantle conditions, and its stability field has been studied in several high-pressure experiments (Ulmer & Trommsdorff, 1995; Wunder & Schreyer, 1997). Nevertheless, the breakdown of antigorite has never been studied using *in situ* X-ray diffraction, and the associated kinetics has never been addressed although it could have a strong influence on the absolute depth, and the depth interval, at which dehydration would occur.

The aim of the HS2131 experiments was thus to study *in situ*, using X-ray diffraction at the ID30 beamline, the antigorite dehydration under high-pressure (1-5.5 GPa) and high-temperature (up to 800°C). Three kinds of starting material were used:

(a) a micronic powder of natural antigorite (Ech 1),

(b) a mix of antigorite powder (95% wt) and crystal seeds of forsterite + enstatite (5% wt), *i.e.* the reaction products at high temperature (Ech 2),

(c) some samples have been saturated with H_2O to investigate the influence of the H_2O content on the pressure-temperature conditions for dehydration (Ech 3).

The samples were loaded in a boron nitride capsule, surrounded by a graphite furnace for heating. The samples were first pressurized using the Paris-Edinburgh vessel, and then slowly heated (≈ 10°C/min). The collection of diffraction spectra during heating gave the opportunity to follow the real time mineralogical reaction of antigorite breakdown. Moreover, the characteristics of the MAR345 imaging-plate enabled to acquire diffraction spectra every 1-2 minutes, suitable for a kinetic study. Pressure and temperature were estimated by an EoS cross-calibration method based on the position of the boron nitride diffraction peaks and those of a gold internal standard (Crichton & Mézouar, 2002). At the end of the experiments, *i.e.* when antigorite diffraction lines disappeared, the samples were quenched and recovered for subsequent analyses: back-scattered electron imaging, electron microprobe analyses and Raman spectroscopy.

Preliminary results

The analysis of X-ray diffraction spectra shows that antigorite breakdown is mainly temperature-dependent (Figure 1). At low temperature (≤ 550 °C), the diffraction spectrum of antigorite displays an additional growing reflection at low angles ($d_{hkl} \approx 12$ Å) without appearance of a new phase (Figure 2). This reflection disappears at 550 °C, when forsterite and a talk-like phyllosilicate nucleate. This reaction results in a first dehydration step. This intermediate assemblage is stable until 700 °C where enstatite grows during a second dehydration stage. This scheme of polyphasic dehydration occurs in constant pressure-temperature conditions whatever the starting material used. Electron microprobe analysis and Raman spectroscopy are currently underway and should bring the complementary information needed to fully characterize the chemical and structural state of each phase produced, and thus discuss the mechanisms involved in antigorite dehydration.

Figure 2 Successive diffraction spectra during antigorite dehydration.
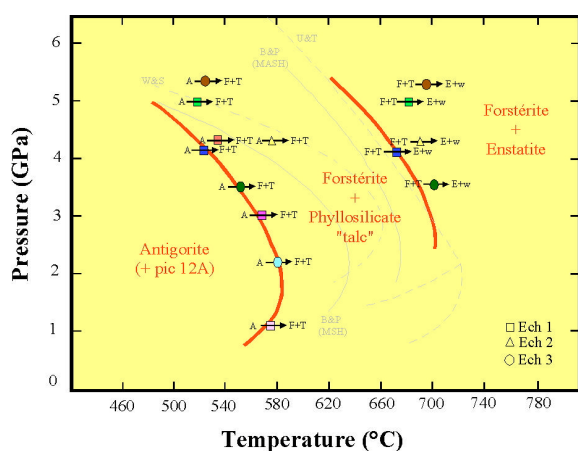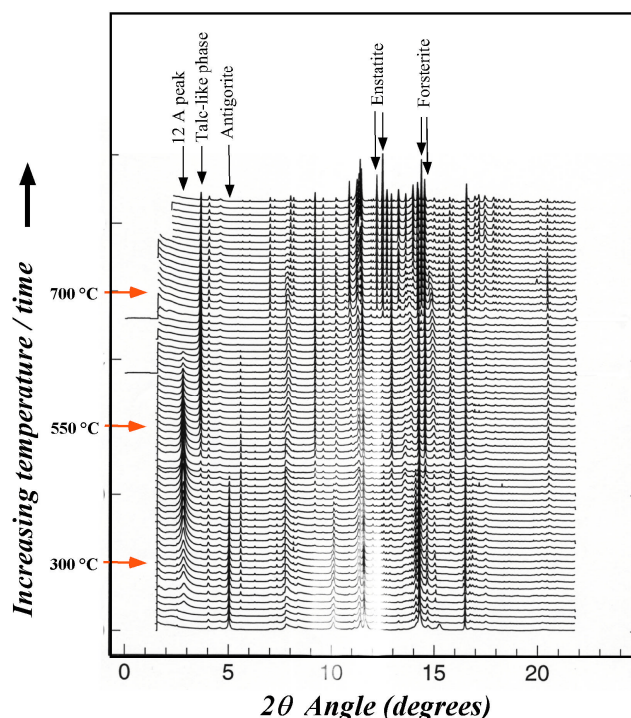

Figure 1 P-T conditions for antigorite decomposition.

Further works

In a second step, transformation-time (X(t)) data for each of the two dehydration reaction will be calculated from the relative intensity of phases diffraction lines. A kinetic law will be determined for each reaction by extrapolating the X(t) punctual data, in the frame of the Avrami's theory of nucleation and growth (Avrami, 1939). These kinetic laws will be associated with a thermal modelling of subduction zone to calculate the amount of water released by the antigorite dehydration as a function of depth; and thus to evaluate its sismogenesis role in subduction zones.

References

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