ESRF	**Experiment title:** 3D Characterization of geometrical effects of pressure solution for reservoir sandstones	**Experiment number**: HS-891
Beamline: ID19	**Date of experiment**: from: 21-04-99 15:00 to: 25-04-99 7:00	**Date of report**: 23-07-99
Shifts: 12	**Local contact(s)**: BOLLER Elodie (PLUO E) LUDWIG Wolfgang (PLUO E)	*Received at ESRF:*

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Report:

All the shifts requested for this project have been allocated and, thanks to the very high efficiency of the ID19 beamline (team and equipment), we did much more than initially projected.

The Ellon field (Alwyn area, North Sea) has been chosen as a first example to study pressure solution consequences on micro-geometry of sandstone reservoir rocks. Indeed, it offers exceptional conditions: One part of the reservoir has been completely cemented (residual porosity about 4%) by calcite at a very early stage of its evolution whether the other part remained without carbonate during all the subsequent evolution. As a result, the actual reservoir comprises two different zones: the cemented one (quartz grains embedded in calcite and preserved in their depositional state) and the non-cemented one where about 10% of the porosity have been lost by dissolution and recrystallization of the quartz grains (pressure solution). Both zones are separated by a very sharp interface.

9 samples have been examined (3 cemented, 3 non-cemented and 3 on the interface) giving a total of 17 scans: 2 with a voxel of $(0.9\ \mu m)^3$, 1 with a voxel of $(1.9\ \mu m)^3$ and 14 with a voxel of $(6.5\ \mu m)^3$. In order to characterize more precisely the interface and the spatial organization in general, 5 samples have been scanned at two different heights with a slight overlapping.

Fontainebleau sandstone is one of the most studied rocks in the world (specially by oil companies) because of its homogeneity and its relative purety (little or even no clay). Nevertheless, there is no precise quantitative model of the diagenesis evolution transforming the Fontainebleau sand into the Fontainebleau sandstone. In collaboration with M. Thiry (Ecole des Mines de Paris), a very well-known specialist of this geological formation, we chose 9 samples at different stages of this evolution. Four has been scanned at $(0.9\ \mu m)^3$, 3 at $(1.8\ \mu m)^3$ and 8 at $(6.5\ \mu m)^3$. 4 samples has been scanned at different heights with overlapping.

North Sea oil reservoir rocks. When dealing with real reservoir rocks, the interpretation of the reconstructed 3D micro-tomographies is complicated by the presence of several minerals in the solid phase. Consequently, it is not possible to associate directly the absorption coefficient of a voxel to its solid content. In order to study the effects of the mineralogy and of the fabric of real rocks, 10 samples of different representative norvegian oil reservoirs have been selected in collaboration with H. Johansen (IFE, Kjeller, Norway). 9 samples have been scanned; 2 at $(0.9\ \mu m)^3$, 2 at $(1.8\ \mu m)^3$ and 9 at $(6.5\ \mu m)^3$.

To prepare future potential projects, 4 other samples have been examined: 2 oak samples (2 scans at $(0.9\ \mu m)^3$, 1 at $(1.8\ \mu m)^3$ and 2 at $(6.5\ \mu m)^3$ for each), a sandstone sample with chlorite grains coating (collaboration with IFP); scans at $(0.9\ \mu m)^3$, $(1.8\ \mu m)^3$ and $(6.5\ \mu m)^3$, and a tuffeau sample comming from a highly damaged building wall (collaboration with CSTB and BRGM); 1 scan at $(1.8\ \mu m)^3$ and 2 at $(6.5\ \mu m)^3$ for two heights with overlapping.

During the experiments, a control section have been reconstructed systematically for each sample giving us a good idea of the quality of the acquired data. We are now facing the main problem of micro-tomography; the 3D reconstruction. One of the research topics of the group CM3D (4 laboratories in Bordeaux) is the use of micro-tomography for 3D modelling. We decided then to set up a collaboration with CREATIS and ESRF (ID19) in order to be relatively autonomous for this step.

Three months after the experiments:

- We have eight 3D reconstructions for ELLON samples plus four of other samples. We are working on the implementation of the reconstruction program on local Unix machines.
- The local tomography technique is very promising for our problems but more work is needed in order to improve the signal/noise ratio (ESRF and CREATIS)
- Global tomography provides us with very high quality data that we have to interpret taking into account mineralogy effects (with geologists from Lille, Paris and Kjeller). Some specific numerical treatment of the data will be necessary to suppress some artefacts due to high absorption contrasts -specially when large pyrite particules are present- (ESRF).
- Numerical characterization of the 3D geometries and numerical modelling of pressure solution and diagenesis are the following steps.