

Chasing light beams

Catherine McCammon and colleagues surmounted experimental obstacles at the European Synchrotron Radiation Facility in France to unlock the secrets of iron in the Earth's lower mantle.

What was the objective of the work?

Our main plan was to study the breakdown of olivine in the Earth's lower mantle using a highly sought after piece of equipment known as a synchrotron, essentially a sub-atomic particle accelerator that emits an intense beam of light, which provides detailed information about the atomic structure of matter. We also tested the feasibility of studying lower-mantle perovskite, and the results of this pilot study turned out to be so exciting that we were able to get rapid access to additional synchrotron time to complete the project.

Why did you choose this particular facility for the experiment?

There are only three synchrotrons in the world capable of doing these experiments, and they are located in France, Japan and the USA. Geographically and logistically the French facility (the European Synchrotron Radiation Facility), which covers the travel and living expenses of scientists working in Germany, was the obvious choice for the majority of the work. However, the multidisciplinary nature of the study also necessitated several trips to the USA.

Any lowpoints?

Sleep deprivation! Users agree to use the synchrotron 24 hours a day, seven days a week, and quite honestly it's hard to imagine letting any of this time go to waste. But we had to plan carefully so that our brains were still functioning by the end of the six-day experiment.

Were there any difficulties associated with the work?

Each time we examined a new part of the sample, roughly the size of a grain of dust, we had to realign it with the synchrotron light beam, which is even smaller, and this probably turned out to be the trickiest part of the experiment. After



Aerial view of the stunning mountain setting of the European Synchrotron Radiation Facility in Grenoble.

many hours of sweating we devised what we thought was the brilliant idea of using motors to move the table that the setup was mounted on, and it worked nicely. But when everything was finally aligned, the problems really began. The table on which our entire experiment rested was apparently levitating against gravity, and we spent the rest of the day shifting the table to try to keep the data collection going. It wasn't until much later that we discovered our mistake: a several hundred kilogram table doesn't come to a complete standstill after being moved. At least the log book entries were entertaining.

What was the highlight of the experiment?

It's difficult to define a single event because there were so many exciting moments along the way, but it would probably have to be the first time we saw the spectrum of iron in the material that we were studying. The spectral peaks were so clean and perfect that there was absolutely no ambiguity, and the head of the group pronounced it a textbook spectrum, which was all the more notable for a sample the size of a dust particle held at pressures close to those experienced at the Earth's core.

Did you learn anything new about yourself or your team members?

I truly discovered what our team members are made of when the equipment broke down at three in the morning. They cheerfully spent the next few hours painstakingly reloading and realigning samples so that the experiment could begin again at 6 am.

What was the atmosphere like at the European Synchrotron Facility?

The European Synchrotron radiation facility is such a stimulating and collaborative environment that you can't fail to be inspired. So many aspects of its operation foster new ideas — the close collaboration between users and facility personnel, the long hours spent pouring over data, the lofty mountain setting in Grenoble, and even the serendipitous meeting of colleagues from other parts of the world in the canteen. We made plans for our return long before we left.

This is the Backstory to work by C. McCammon and co-workers, published on page 684 of this issue.

