ESRF	**Experiment title:** Investigating nano-scale bone structure in brittle bone disease	**Experiment number**: MA-2466
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Report:

Human bone's mechanical properties derive from its hierarchical structure spanning molecular-to-macroscopic length-scales. The nano-scale structure is the key to developing strength and plasticity in bone [1, 2], where the structure consists of a mineral-collagen composite, termed a fibril. The development of imaging techniques capturing the three-dimensional (3D) nano-level structure is essential to determine how aging and diseases are associated with the reduced fibril-level plasticity and increased fracture risk. In our experiments at the ESRF in September 2014, we investigated the 3D structure of human cortical bone in two healthy individuals using coherent x-ray diffraction imaging (CDI).

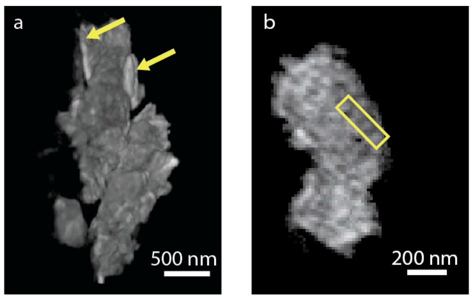

Figure 1: A) 3D reconstruction of the bone fragment from the 14-year-old individual shows large extrafibrillar mineral platelets (yellow arrows). B) 2D slice from the reconstructed bone fragment from the 2-month-old individual shows the fibril structure. The fibrils within the yellow box have a periodicity of 74 nm.

Femoral cortical bone samples from a 2-month old and a 14-year old individual were ground to 5 μm^3 and deposited on Si_3N_4 membranes. The samples were measured via tomographic scans at the ESRF beamline ID10 with 8 keV coherent x-rays. A phase retrieval algorithm was applied to reconstruct the 3D electron density distribution from the 3D Fourier intensity data with a 15-nm voxel size.

From the reconstructed 3D images of the bone fragments, we were able to observe large mineral crystals outside of the fibrils (Fig. 1A). Additionally, in the 2D slices, fibrils are visible, where the periodic arrangement of collagen and mineral cause a light and dark banding pattern (Fig. 1B). We are currently preparing a manuscript that supplements the CDI images with histology, fourier transform infrared imaging, and mechanical testing to characterize the bone structure, composition and mechanical properties at multiple length-scales. From these experiments, we aim to understand the role of extrafibrillar mineralization in bone's mechanical integrity.