ESRF	**Experiment title: High resolution SAXS/WAXS investigations of mineral nanoparticles in loaded bone and correlations with the osteocyte cell network**	**Experiment number**: SC-4897
Beamline: ID 13	**Date of experiment**: from: 19 October 2018 at 08:00 to 23 October 2018 at 08:00	**Date of report**: Feb. 2020
Shifts: 12 shifts	**Local contact(s)**: Dr. Manfred Burghammer	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

SCHEMENZ Victoria

WAGERMAIER Wolfgang

LI Chenghao

TANG Tengteng

WEINKAMER Richard

Max Planck Institute of Colloids and Interfaces, Department of Biomaterials
Am Mühlenberg 1
14476 Potsdam, Germany

Report:

We investigated the mineral nanoparticle properties of cortical bone from C57BL/6J mice (26 weeks) where an in-vivo loading was performed on the left tibia – the right ones serve as control limbs. Using small angle X-ray scattering (SAXS) with micrometer resolution we characterized the bone material at ID 13 with the aim to determine the mineral particle size and orientation as a function of the position in relation to the OLCN which was imaged before using confocal microscopy. Imaged with in-vivo microCT, we detected areas of bone formation and resorption.

Generally, the structure of bone is adapted at every hierarchical level to its mechanical needs, i.e. the extra cellular matrix (ECM) is subjected to a lifelong interplay between bone resorption by osteoclasts and bone formation by osteoblasts (Weinkamer and Fratzl, 2011). Osteocytes are embedded in the bone matrix and orchestrate the remodeling process via fluid flow in the lacuno-canalicular network (LCN) and likely contribute directly to mineral homeostasis (Kerschnitzki, 2013).
Quantitative backscattered electron imaging shows the mineral content of the sample surfaces. Combining our methods we confirm that the new formation occurs without a phase of woven bone (Checa et al., 2015). Moreover, first analyses show evidences of correlations between osteocyte network architecture and mineral particle characteristics (see Figure 1), which supports our hypothesis that osteocytes directly influence the mineralization process.

The experiments performed in October 2018 were very succesful and we could measure all samples as planned. We are currently writing up a manuscript which presumably will be submitted to a peer reviewed journal in 2020.

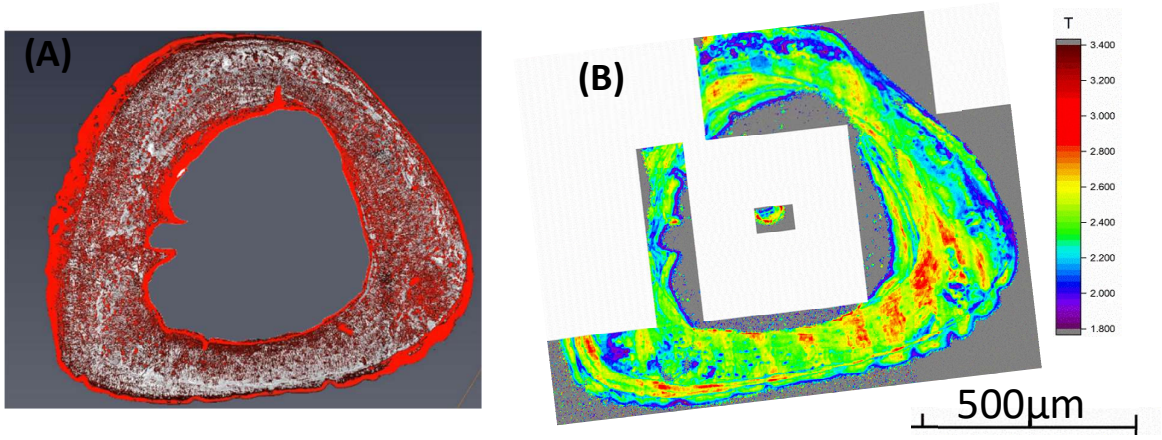

Figure 1: **Scanning small angle X-ray scattering results**. A) Backscattered electron image showing mineralization level in grey scale. The osteocyte lacunae and soft tissue are displayed with red lines. B) Mean particle thickness (T parameter) color-coded.

References:

Checa, S., Hesse, B., Roschger, P., Aido, M., Duda, G. N., Raum, K., Willie, B. M. Skeletal maturation substantially affects elastic tissue properties in the endosteal and periosteal regions of loaded mice tibiae, Acta Biomaterialia, Volume 21,2015, 154-164,

Kerschnitzki, M., Kollmannsberger, P., Burghammer, M., Duda, G.N., Weinkamer, R., Wagermaier, W., Fratzl, P., 2013. Architecture of the osteocyte network correlates with bone material quality. J. Bone Miner. Res. 28, 1837–1845.

Weinkamer, R., Fratzl, P., 2011. Mechanical adaptation of biological materials — The examples of bone and wood. Mater. Sci. Eng. C 31, 1164–1173.