Bone

Bone falls rather heavily between two stools in acoustic microscopy. Soft tissue can be cut into thin sections. It can be imaged with a standard tone burst KSI SAM, focused either on the substrate to let attenuation dominate the contrast, or on the top surface of the section to let impedance dominate. Quantitative measurements of thickness, velocity, impedance, and attenuation can be made using time resolved techniques to separate the echoes from the top and bottom of the section. Structural tissue with a high collagenous content has both a higher velocity and a higher attenuation than ofter soft tissue. Tooth enamel is at the other end of the stiffness spectrum for biological materials. It supports Rayleigh waves very nicely, with a velocity around 3000 m s -1.

A term bone does not designate one single material, rather it describes a whole spectrum of heterogeneous anisotropic composites; indeed the properties vary greatly even within a single bone. The value of the acoustic micrographs of bone is that they reveal the elastic nature of those inhomogeneities.

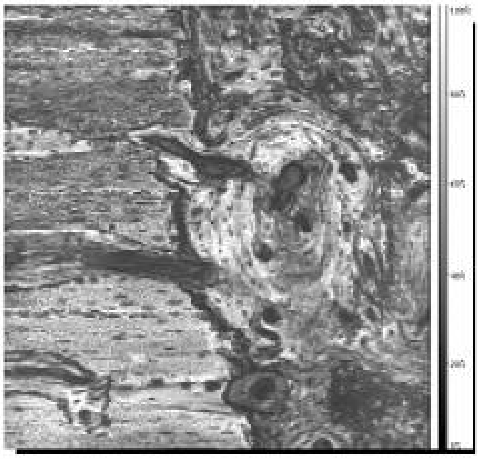

Fig. 1

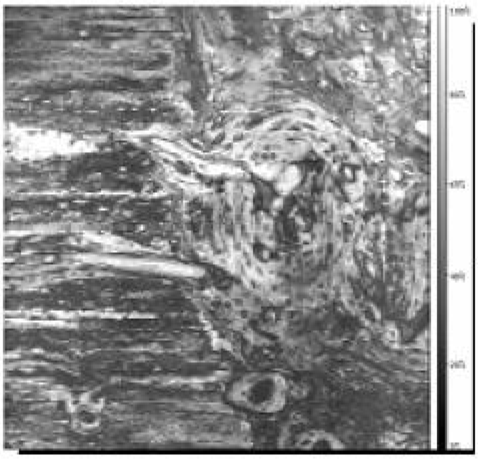

Fig. 2

Courtesy of Dr. Zhai, Germany

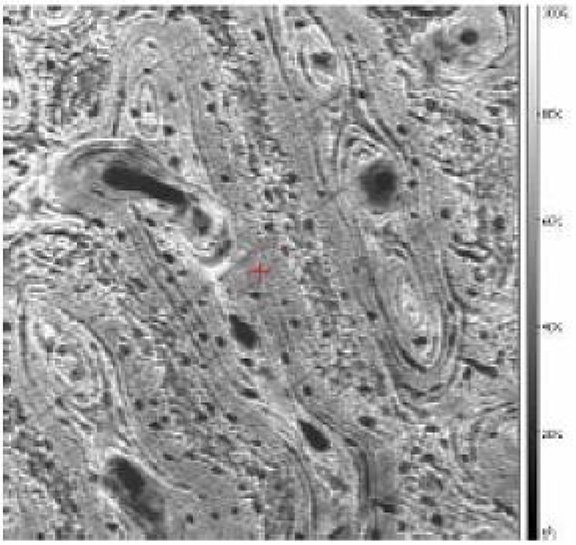

Fig. 1: sheep tibial plexus bone, different impedances are visible, the brighter the grey value the higher the impedance
frequency 400MHz

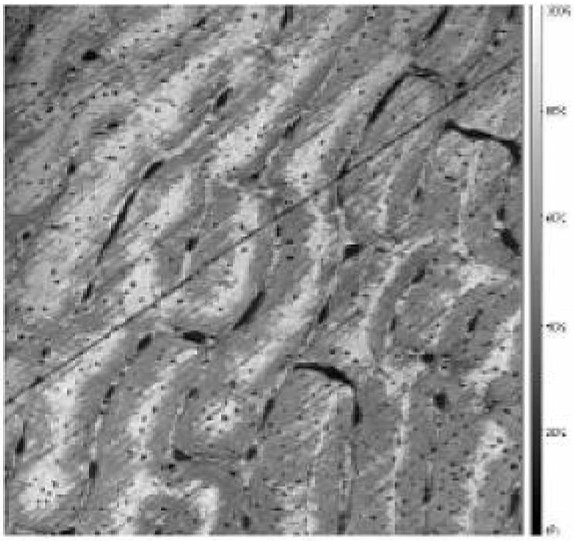

Fig. 2: sheep tibial plexus bone at the transition to the lamella bone, different impedances are visible, the brighter the grey value the higher the impedance.
frequency 400MHz

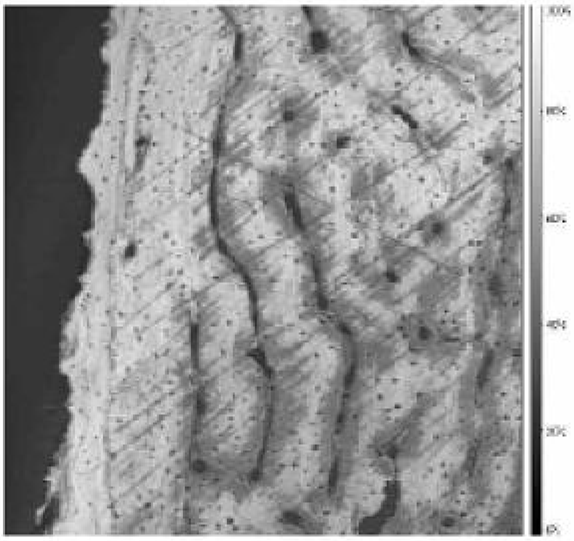

Fig. 3: The same bone as in image 2, however with bone skin, higher impedance at the border is visible.
frequency 400MHz

Courtesy of Martin-Luther-Universität Halle, Medizinische Fakultät, Klinik und Poliklinik für Orthopädie, AG Biomechanik & Strukturforschung, PD Dr. H.-J. Hein

Human toe bone

A section through a human toe bone. The circular patterns relate to the Haversian system responsible for blood flow in the bone. The regions around the holes are osteons. The osteons appear with different contrast in this picture. As always this relates to different mechanical properties. In this case it enables to distinguish the different ages of osteons, because the variation in contrast is related to different degrees of mineralization.

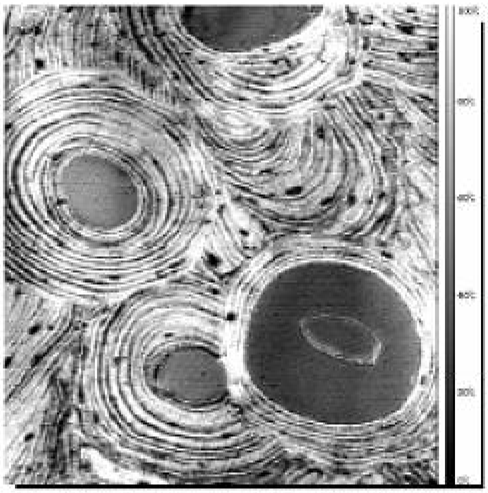

Fig. 1: human toe bone, 90° cut, osteons are visible,
image width 500µm, frequency 400MHz

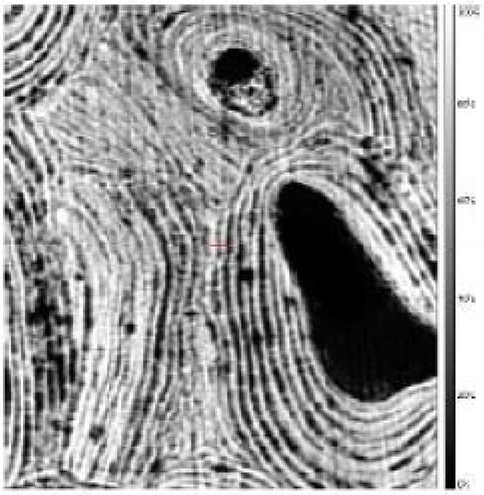

Fig. 2: human toe bone, 45° cut,
image width 312µm, frequency 400MHz

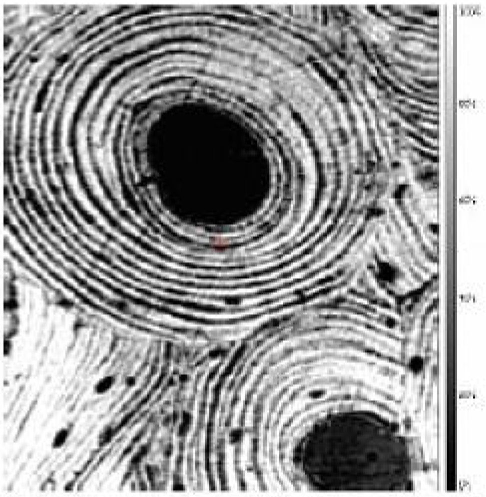

Fig. 3: human toe bone, 90° cut, good shaped osteons are visible,
image width 500µm, frequency 400MHz

Courtesy of Martin-Luther-Universität Halle, Medizinische Fakultät, Klinik und Poliklinik für Orthopädie, AG Biomechanik & Strukturforschung, PD Dr. H.-J. Hein

Rabbit tibial bone

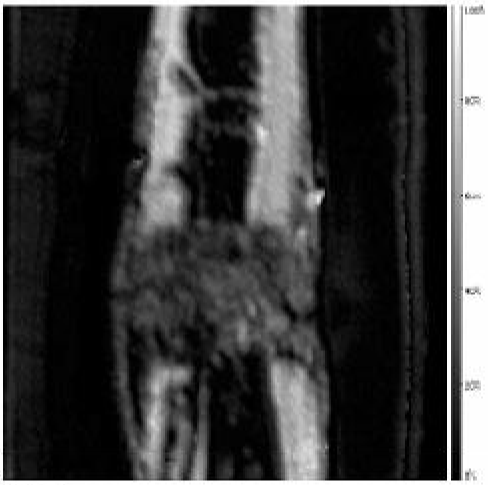

Fig. 1

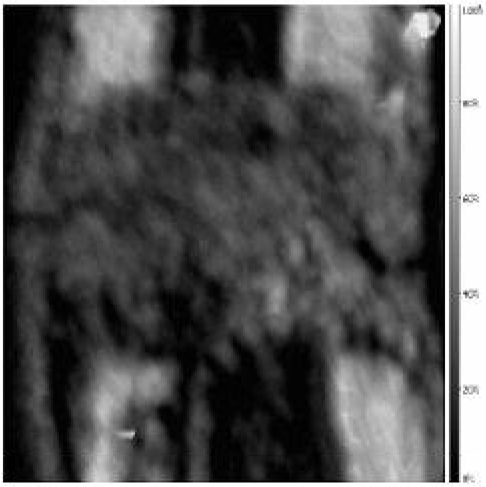

Fig. 2

C-scan picture of a specimen of a rabbit tibial bone taken at 50MHz. The tibia was subjected to osteotomy and entered into a bone distraction osteogenesis (bone elongation) project to study the mechanical properties of the osteogenic zone (new bone formation), which is the relatively dark zone of the picture. The field is 20 by 20 mm.

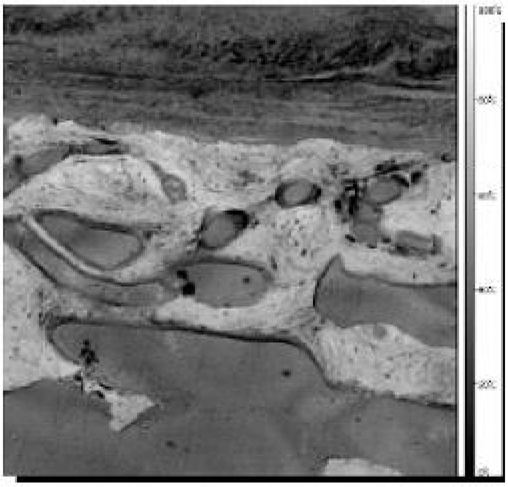

Fig. 3

Same object as above, with 400MHz, close to the region of new bone formation. The field is 1 by 1 mm. At the top of the picture is soft connective tissue.