We have been involved in a joint research program with Drs. A.C. Kitchener, G.K. Bacon and J.F.V. Vincent (University of Reading) on the relationship between hydroxyapatite (HAp) crystal orientation and the elastic properties of antler horn from the extinct Irish Elk. Our colleagues have measured the ratio of intensities of the 002 and 111 reflections in the neutron diffraction pattern of specimens from the dorsal, ventral, anterior and posterior quadrants of one of these 12,000 year old antlers. The ill intensity is essentially a count of the total number of crystallites being measured within the specimen, while the 002 intensity is a measure of the number of crystallites whose "c" axes are parallel to a specific direction. For a randomly oriented powder of hydroxyapatite, the ratio of 002/111 intensities is very nearly unity. In the femur of a 20 year old human the 002 reflection is enhanced 3-fold over that found in the random powder, indicating a preferred orientation of crystallites whose "c" axes are aligned along the long axis of bone (Bacon, R.K. Griffiths, "Texture, stress and age in the human femur", J. Anat. (1991) 143, 97-101). Kitchener et al report that the degree of preferred orientation of HAp in the tension side of the antler has a higher degree of preferred orientation than that found in the compression side.

A section of the same horn, just adjacent to that from which the specimens were taken for neutron diffraction experiments, was used to make ultrasonic wave propagation and scanning acoustic microscopic measurements of the elastic properties. Prior to such experiments, the mineral density distribution in the section was measured by computer tomography in a C.G.R. (France) system. The section was then cut into dorsal, ventral, anterior and posterior specimens for standard ultrasonic wave propagation measurements to obtain average elastic moduli values. In addition, a new laboratory built reflection scanning acoustic microscope (SAM) was used to obtain the variations in acoustic impedance properties across the specimen's area. In this case the acoustic impedance \( Z = \rho v (\rho \text{ is the sample density, } v \text{ is the longitudinal velocity}) \) is obtained on a grid of 256 x 256 points across the specimen's surface. Using a spherically focused transducer at 20 MHz, a resolution of approximately 100 \( \mu m \) is obtained. While not providing the elastic modulus directly, the system does provide a mapping closely related to modulus. The mineral concentration across the whole section, and in the part preserved for specimens for neutron diffraction experiments, was measured by the CAT scan. The SAM acoustic impedance amplitude measured along an imaginary line through the mid-portion of the smaller individual dorsal and ventral specimens cut from the whole section. What is apparent is the difference in mineral distribution between the dorsal and ventral sections. It is clear also that the strong inhomogeneity in elastic properties correlates very well with the mineral distribution and crystallite orientation; the same degree of correlation is observed for the other aspects as well.

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