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PHYSICAL AND CHEMICAL INVESTIGATION OF FREE BODIES IN ARTICULAR OSTEOCHONDROMATOSIS

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Physical and chemical analysis of the newly formed calcified bodies in articular osteochondromatosis was carried out. X-ray diffraction showed that these bodies consisted of carbonate apatite from the group Francolite-Dahllite. Infrared spectroscopy, and chemical and differential thermal investigations supported the data gained from the X-ray diffraction analysis.

Key words: articular osteochondromatosis; crystallography; derivatography; carbonate apatite; Francolite; Dahllite

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Articular osteochondromatosis was first described by Ambrois Paré (Pontiville et al. 1965) and the symptoms and pathology of this disease are well known. However, no extensive physical and chemical analysis of the newly formed calcified bodies was found in the available literature. In the following, a patient with this disease will be described. This case is of interest because the removed calcified bodies were investigated both physically and chemically.

PATIENT AND METHODS

J. J., a male aged 53 years, was admitted to our Department because of stiffness and pains in both knees. X-ray examination revealed severe osteochondromatosis of both knees. A synovectomy was performed on the right, and later on the left knee, and the loose osteocartilaginous bodies, tightly filling the joint cavity, were removed.

The removed calcified bodies were carefully cleaned from the soft tissues, lyophilized, and then ground to 0.5–1.00 mm grain size. The fat was extracted with fine petrol and the dry specimen was ground again to 325 mesh fineness. With sedimentation in alcohol the smallest and the coarsest parts were eliminated, and the remainder dried and rehomogenized in an agate mortar before analysis.

The following methods and instruments were used to clarify the crystallographic structure of the free bodies:

X-ray diffraction analysis. Instrument used: Mueller Mikro 111 diffractometer.

Infrared spectroscopy. Instrument used: MOM Spektromom Type 2000 rock salt prism IR spectrophotometer.

Chemical analysis. This analysis corresponded to that used generally in wet chemical analysis of sedimentary rocks containing organic matter.

Thermal analysis. Instrument used: MOM Derivatograph.

RESULTS

X-ray diffraction (Figure 1). This revealed that the investigated sample was a carbonate apatite from the group Francolite-Dahllite. It can be assumed that the sample investigated was an intermediary member of the isomorphous substitution series.

Figure 1. X-ray diffractogramme of the free bodies in articular osteochondromatosis. The pattern shows a rather typical crystallized apatite variant.

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Infrared spectroscopy. A well distinguished peak and a joining shoulder could be observed showing an unstable energetic arrangement (Figure 2).

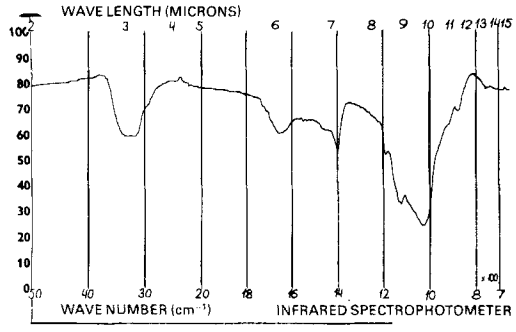

Figure 2. Infrared spectrum of the free bodies in articular osteochondromatosis showing an unstable energetic arrangement.

Chemical analysis. The compounds found in the wet chemical analysis are presented in Table 1. CaO and P_2O_5 seemed to be the major constituents; several minor elements were however also found.

Table 1. Wet chemical analysis of free bodies in articular osteochondromatosis

	Per cent
SiO_2	0.29
TiO_2	0.00
Al_2O_3	0.60
Fe_2O_3	0.083
MnO	0.06
MgO	tr.
CaO	37.37
Na_2O	1.16
K_2O	0.06
P_2O_5	26.62
F	2.22
Cl	0.08
H_2O/–/120C°	5.60
Ignition loss from this:	26.60
CO_2	3.66
Organic C	9.23
O loss	–0.95
Sum total	99.793

Differential thermal analysis (Figure 3). This showed that the inherent water found at the chemical analysis originated partly from the decomposition of the organic material remaining in the sample, partly from the water content of the crystal structure.

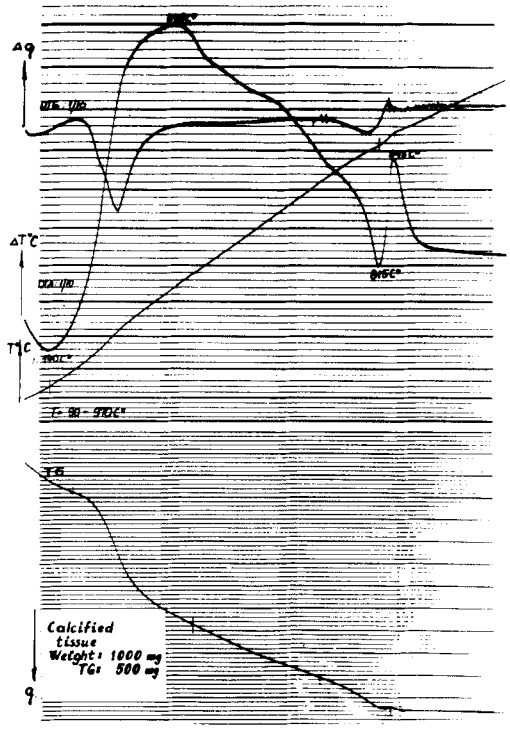

Figure 3. Derivatogramme of the free bodies in articular osteochondromatosis, showing a quite uniform weight loss, so the first derivate of the TG curve could help in the determination of the water content of the crystal structure.

DISCUSSION

The X-ray diffraction pattern fits very well with that described by McConell (1960, 1938) for Dahllite and Francolite. On the basis of the high fluorine content the specimen could be attributed to the Francolites which contain a large quantity of fluorine. If, however, McConell's crystallochemical calculations are carried out, a crystallochemical formula can be derived which does not equal either Dahllite or Francolite but is intermediary between them. The crystallochemical formula of the carbonate apatite of the calcified tissue investigated based on this calculation is as follows:

$(Ca_{8.95}.Na_{0.5}.H_3O_{0.4}.C_{0.12}.K_{0.018}.Mn_{0.01}.)$
$(P_{5.02}.C_{0.97}).(F_{1.57}.OH_{0.4}.Cl_{0.03})$

One must also take into consideration in a complicated case like this the existence of mixed crystals. This would not be in contradiction to the concept described above; it would even mean according to Keppler (1969) the solution of the whole carbonate apatite problem. The crystal chemistry of the mixed crystal, however, is for the time being unknown.

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