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SANS STUDIES OF FRACTAL PROPERTIES OF APATITE-CARBONATE ROCKS

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Many minerals in nature can be regarded as porous media with surface or volume fractal properties /1/. Their scaling characteristics play an important role in the formation of physical properties of these media and the processes therein. There are, in particular, hydrodynamics flow through porous media, water-oil distribution, dielectric properties of brine-saturated rocks, elastic properties and fracture /2/. Identification of fractal properties and measurement of fractal dimension are thus a first "preparative" stage for these studies. Small angle scattering (of neutron, x-rays, etc.) has been used for this goal /3-4/.

It is well established that the scattering intensity as a function of the wave-vector transfer, I(q), for q^{-1} corresponding to the medium scaling range falls of as

$$I(q) \sim q^{-D} \qquad (1)$$

for volume fractals; and as

$$I(q) \sim q^{-(6 - D)} \qquad (2)$$

for the surface fractal /3-4/ .

Here $2 < D < 3$ is the fractal dimension of either topological 3-d porous particle or 2-d surface of the particle, respectively.

The interest in the mineral components of apatite-carbonate ore is caused by their particular colloid properties relevant to selective flotation. To build a theory of elementary act of heterocoagulation between the mineral particle and the gas bubble we need a picture of the particle pore structure.

A small angle neutron scattering (SANS) will be taken as a tool for the study of this picture. The efficiency of SANS for the study of rocks and the other strongly inhomogeneous structures is due to two main features of neutron interaction with matter. Firstly, neutrons are capable to penetrate deep onside the sample which allows one to probe its inner structure. Secondly, since the scattering amplitude of the basic elements of rock substances, viz carbon, oxygen, silicon, phosphorus, calcium, etc. are close, then in the small wave-vector transfer (q) experiments rocks behave like two phase systems exhibiting the interpenetrating "rock space" and "pore space".

The measurements are planned on the five types of calcites ($CaCo_3$) and two types of apatites extracted from ores of different deposits. The considered ores are known to be characterized by different apatite extraction coefficients though being of practically the same chemical composition; the only a priori difference in the types of calcites and apatites under study is that they have been extracted from, in this sense, different ores.

The samples are powders composed of grains of $\sim$ 40 μm (calcites) and $\sim$100-200 μm(apatites) average size, which fill a cylindrical quartz cuvette 2mm thick and 42 mm in diameter.

Some preliminary measurements have been performed at the SANS installation at the pulsed reactor IBR-2 (the Laboratory of Neutron Physics, the JINR, Dubna) . Verification of unimportance of the multi-scattering phenomena was shown for our samples. The law of scattering is determined by the formula (2) in the range of $10^{-2} \leq q \leq 10^{-1}$ Å^{-1}.

However, this information is not sufficient for the true conclusion of surface fractal properties of the mineral cores. As it is known, the measurement I(q) over the range of $10^{-4} \leq q \leq 1$ Å^{-1} can be carried out at D11 of the ILL HFR.

The scaling treatment in the range of q^{-1} would be of basic importance for the determination of the surface fractal properties and respectively, for building a theory of elementary act of heterocoagulation between the mineral particle and the gas buble.

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