INTRODUCTION

The discovery of radioactivity has brought about a revolution in our ideas in physics, and also in our ideas about the energy content of the earth. The earth has at its disposal a continuous energy source in its interior which originates from the disintegrating nuclei of the radioactive constituents of the earth's crust. In addition to the heating produced by this radiation, which controls the heat content of the earth, we know from experiments that other effects are produced in solids, such as ionization, colouration, luminescence, thermoluminescence, and even the destruction of the crystal structure of the solid. Which of these effects one can find in Nature depends on the mineral investigated and on the intensity of the radiation itself.

It was Pearsall (1830) who first showed that a colour was produced by the action of an electric spark on a colourless fluorite crystal, and this corresponded to the natural colour of fluorite; thus a possible explanation of the pale colours of minerals was discovered. He coloured a fluorite crystal, rendered colourless by heating, blue to pink with the spark from a Leyden jar. According to him "Could it not be that the natural fluorite owes its colour to a special structure ? Could one not suppose that Nature employs this same means and that it is electricity which produces the colour in the natural state ? Both the natural and artificial colour are destroyed by heat, and the colour as well as the phosphorescence can be restored repeatedly by electricity."

One can not doubt that in his experiment it was the short wavelength ultra-violet light from the spark that produced the colour and the phosphorescence, which was in fact the thermoluminescence. If one substitutes the work radiation for electricity in the expression, one can see that Pearsall was as near to the present day explanation of colouration and thermoluminescence as might be expected before the discovery of radioactivity. The colouration of certain minerals is particularly indicative of

a radioactive effect, and the first suggestion that the natural colouration of minerals is caused by radioactivity was due to Siedentopf (1905). The effect of natural radioactivity on the luminescent properties of minerals was first recognized in thermoluminescent minerals, i.e. those which glow on heating, and it was assumed that the initial excitation energy was supplied by the rays from the radioactive substances.

The study of colouration and luminescence has given an insight about the structure of solids, and of the mechanism of light emission. For the mineralogist and an earth scientist, the natural colours of minerals produced by radiation, as well as their colourability under artificial conditions, can be of importance in many respects. The former are the result of a physical process which has been operative throughout geologic time, and therefore give, with correct interpretation, information about those processes in the strata; the later can show up variations which could not be detected otherwise. Luminescence analysis is very suitable for the identification of traces of impurity which can influence the structure of the mineral, and can, under certain conditions, depend on the age of mineral and its mode of formation. From experiments on the luminescence and thermoluminescence of fluorite, an explanation has been given of the dependence of the rare earth content on the mode of formation of the fluorite and their distribution in this mineral (Przibram, 1956).

The results in this field are not so simple to interpret, as it is not only a question of the presence in the mineral of an element which luminesces or the mineral produces thermoluminescence, and of how it is built into the crystal, but also of the thermal pretreatment of the specimen, the presence of impurities, and the effect of radioactivity. The present studies form a part of such investigations which would in a small way reveal the mystry of the effects of radioactive radiations on crystals.