Heating experiments on amazonite.

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Summary. The rate of decolorization of a Norwegian amazonite was studied at various temperatures: near 500° C. it was almost instantaneous, becoming successively slower with lower temperatures, until at 300° C. no change was visible in 10 hours. It is concluded that the colour is stable indefinitely below about 270° C. and that this is the maximum temperature at which the colour could have appeared.

IT is well known that the green colour of amazonite disappears on heating. Having at my disposal excellent specimens of a very intensely and evenly coloured amazonite (from Tørdal in Telemark, Norway), I have examined the velocity of decolorization at various temperatures. The actual experiments were very kindly carried out for me by Prof. Ivan Th. Rosenqvist, whose laboratory (in Norges geotekniske institutt, Oslo) was already equipped with suitable apparatus. I am also indebted to Dr. Rosenqvist for valuable comments on the results. The heated samples were small cleavage fragments a few millimetres thick, so that they should quickly attain the temperature of the oven. On complete disappearance of the green colour the amazonite is nearly snow white (colourless in thin flakes); therefore, even the slightest remnants of green colour can easily be observed. I would add here that the amazonite has been examined spectrochemically both unheated and after complete decolorization, and that no change in the content of trace elements (essentially Rb, Pb, Tl) could be observed. Sometimes partly white amazonite crystals may be found in the pegmatites; these are also spectrochemically homogeneous.

The data obtained from the heating experiments are as follows:

T, ° C.	t, hrs.	% loss of colour	T, ° C.	t, hrs.	% loss of colour
500	<0·1	100	400	1	85
450	0·5	99	360	5	90
450	0·4	95	300	16	<80
450	0·3	90	270	10	0
400	5·5	99			

It must be remarked that the figures, except those for t, are approximate. The temperature readings may differ by 10° to 20° from the

correct values. The decolorization percentage was determined by a rough colorimetric method, using a liquid whose colour was approximately that of the unheated amazonite; the determinations are very uncertain at low percentages, but fairly safe for percentage decolorizations around 90.

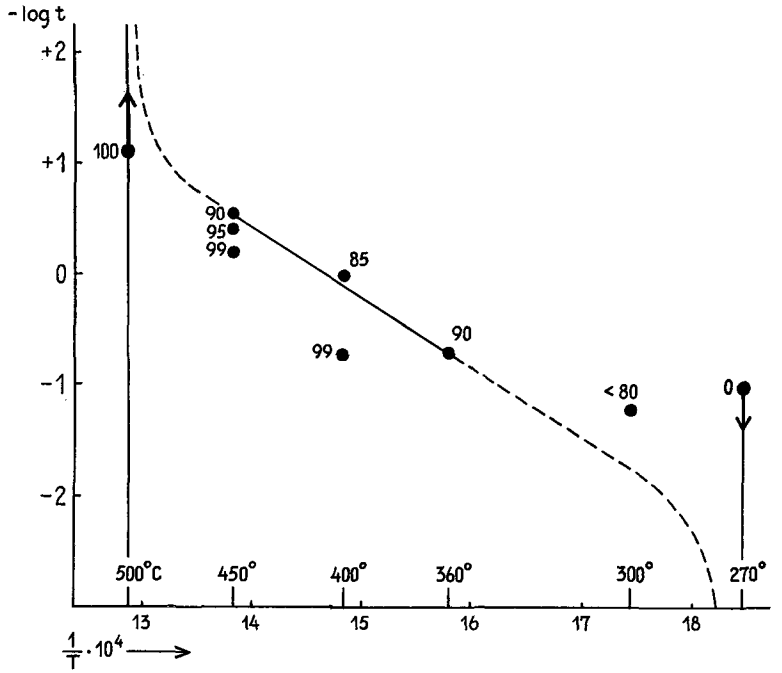

FIG. 1.

The results may be plotted in a diagram (see figure) with $1/T$ (degrees absolute) for abscissa and log $1/t$ (which is proportional to the log of specific rate of decolorization) for ordinate. It is seen that the curve for 90 % decolorization can be drawn fairly safely. The curve is approximately straight in the middle portion, at least from 450° C. to somewhat below 350° C. (The curves for various percentages are expected to be all parallel; it can be seen that the 85 % and 95 % curves will be approximately parallel to the 90 % curve.) Above 450° C. the curve bends upwards and must be supposed to approach a limiting ordinate near 500° C. asymptotically. In the same way it bends downwards somewhere below 300° C.; the limiting ordinate is here probably near 270 ° C. The activation energy of decolorization can be estimated from the slope

of the straight part of the curve. It turns out to be of the same order of magnitude as the activation energies of various diffusion and decomposition processes, about 30 000 cals./mole.

From these observations it seems justified to conclude that the colour of amazonite is due to 'colour centra' in the same way as, for instance, the blue colour sometimes found—and easily developed artificially—in rocksalt. The nature of the colour centra in amazonite is not known. From the above data it is obvious that they were formed at temperatures below 300° C., probably at about 250° C., that is in already crystallized and considerably cooled felspar. This is in accordance with the field observations, which strongly indicate that the green colour originated in connexion with the formation of cleavelandite pegmatite veins in the already existing microcline pegmatite. It is sometimes observed that the green amazonite colour is exceptionally intense along the immediate contact towards a cleavelandite pegmatite vein. The new elements introduced during the formation of the cleavelandite pegmatite were chiefly F, Li, Be, Sn. Fluorine was especially abundant, as shown by the considerable quantities of topaz and lithium micas present in these veins. The colour centra may be due to the action of F on the microcline crystals. Perhaps F ions replace a few of the O ions in the crystals, thus creating the unstable distribution of charges which is supposed to produce this kind of colouring.

Literature on colour centra and defective structures.

HAUFFE, K. Reaktionen in und an festen Stoffen. Springer, Berlin, 1955.

PRZIBRAM, K. Verfärbung und Lumineszenz. Springer, Wien, 1953.

Both of these books contain numerous references to original papers.