There are no evidences of introduction of material into the rock, hence all of the new mineral development must be accounted for by reconstitution of the original rock materials.

The biotite, actinolite, and graphite of the groundmass are considered normal developments from a glacial rock flour consisting of fine particles of quartz and limestone or dolomite, clay, carbonaceous and ferruginous materials. It is believed that the solid actinolite masses have developed from the formerly existing limestone and dolomite fragments. An interesting problem connected with diffusion in metamorphism is presented by most of these masses. As previously stated the rim usually has developed large crystals while the center may contain finer grained actinolite, and outside the coarse rim actinolite replaces the matrix in decreasing amount for a distance of about 5 mm. It would be expected that when a rise of temperature takes place the most vigorous development of new crystals would be at or near the boundary of the two substances involved, hence the coarse actinolite on the rims. Slower diffusion would allow silica and iron to penetrate farther into the carbonate masses but smaller crystals would result. Calcium and magnesium oxides have escaped beyond the coarse rim causing the development of the replacing actinolite. According to Harker,[3] diffusion in metamorphism is restricted to a distance of "a small fraction of an inch." Evidences here would confirm this supposition. The presence of sphene in the outer replacement zone only can be explained by the presence here of calcium and titaniferous materials in the original deposit.

[3] Harker, A., Metamorphism, p. 19. Methuen & Co. (1932).

DIFFERENTIAL THERMAL CURVE OF SIDERITE

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While working on the mineralogy of a drill core of bauxite (1) it was found necessary to determine the standard differential thermal curve of siderite. A search of the literature for data on this mineral revealed that only Speil (2) had described the curve. He listed a strong endothermic peak at 590° C. and an exothermic reaction at about 720° C. The siderite curve published by Berkelhamer (3) shows a very strong endothermic reaction. After this reaction the curves goes a considerable distance above the base line but he evidently does not consider this as an exothermic reaction because he makes no mention of it.

Just before the bauxite investigation was completed Cuthbert and Rowland (4) published a new curve for siderite. Using siderite from the same locality, Roxbury, Connecticut, the writer was unable to duplicate their results.

Recently Kerr and Kulp (5) have published differential thermal curves for siderite from various localities. The curves all show both endothermic and exothermic peaks.

Both an endothermic and an exothermic peak should be expected for this mineral. Kelley and Anderson (6) list the following data for siderite:

$FeCO_3$	$FeO + CO_2$	$\Delta H = 19,790$ cal/mol
$3FeO + O$	Fe_3O_4	$\Delta H = -73,000$ cal/mol
$2FeO + O$	Fe_2O_3	$\Delta H = -66,000$ cal/mol

They found that the dissociation of siderite to ferrous oxide and carbon dioxide is an endothermic reaction with a heat of dissociation of 19,790 calories per mol. From similar thermodynamic calculations they found that the oxidation of the resulting ferrous oxide to either Fe_3O_4 or Fe_2O_3 is a strong exothermic reaction. They calculated that the dissociation temperature comes at 459° C., but state that this temperature seems too low. The differential thermal curves show, however, that siderite starts to dissociate at almost exactly this temperature.

The ferrous oxide undoubtedly oxidizes to Fe_3O_4 because all of the samples, after dissociation, were strongly ferromagnetic. Whether or not Fe_2O_3 also forms has not as yet been determined.

Kerr and Kulp mention that "The cause of the reported exothermic peak is not clear." The above explanation should clear up this point. They also raise the question as to whether or not the oxidation of the ferrous oxide to the ferric state is fast or slow. The curves obtained show that the rate of oxidation is very fast and that the reaction takes place immediately after the removal of the CO_2.

On the basis of the above data and a curve in the unpublished thesis of Beck (7) (that is essentially the same as those listed by Kerr and Kulp), it seems clear that the exothermic peak as well as the endothermic peak has been established for siderite.

The reason for the different results obtained by various authors using the same material is not clear. The writer has found, however, that some of the discrepancies are due to differences in sensitivity of the equipment used. Our curves were obtained by the use of a differential thermal apparatus using a recording ammeter and an amplifyer constructed by Mike Frueh under the direction of Dr. H. W. Fairbairn in the geology laboratory of the Massachusetts Institute of Technology.

Samples of a drill core of bauxite were tested in this instrument and in one in the ceramic department of M.I.T. that is the same as the apparatus described by Berkelhamer (3) which utilizes a photographic method of recording. The resulting curves, which will be published soon, are quite different for the two types of recording apparatus. The electronic method of recording seems much more sensitive than the photographic method.

On the basis of the above observation it would seem advantageous for workers in this field to exchange samples in order to evaluate the influence of different instrumental characteristics on the thermal curves for the common clays and carbonates.

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MODE OF OCCURRENCE OF TITANIUM AND ZIRCONIUM IN LATERITES

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TITANIUM

Although titanium is commonly present in amounts up to three or four per cent in some bauxites and laterites, frequently no titanium mineral can be visibly identified. During an investigation (5) of a drill core of Arkansas bauxite it was found that the titanium occurs in at least four different forms:

(1) As sphene.
(2) As ilmenite.
(3) As one of the polymorphous forms of TiO_2, principally brookite.
(4) In substitutional solid solution in the aluminum minerals.

Sphene was observed in thin sections and was collected from several horizons in the drill core. The products from concentration experiments reveal that sphene dissolves readily when exposed to circulating solu-