DIFFERENTIAL THERMAL ANALYSIS OF HYDROTHERMAL ALTERATION PRODUCTS FROM THE VEMPALLE LIMESTONE BELT, CUDDAPAH FORMATIONS

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INTRODUCTION

VEMPALLE LIMESTONE BELT of Cuddapah formations is hydrothermally altered in the neighbourhood of basic intrusions. Steatite and asbestos are the two end-products of this alteration. It is very interesting to note that these two minerals which are the result of hydrothermal alteration in the same country rock in the neighbourhood of the same basic intrusion are not found in association with each other. The altered rocks in the steatite zone are sometimes foliated in nature whereas in the asbestos zone they are always massive. The present study is intended to identify the mineral products in the altered rocks from the steatite and asbestos zones of hydrothermal alteration.

LOCALITY AND NATURE OF ALTERED ROCKS

Samples were collected from three places of hydrothermal alteration in the neighbourhood of Mutchukota village (Long. 77° 52' 38" and Lat. 14° 51''), Anantapur District, Andhra Pradesh. Essentially, the hydrothermal alteration of Vempalle limestone belt of Cuddapah formations can be differentiated into (i) steatite mineralization and (ii) asbestos mineralization. In the present case, the former is noticed at two places, one near Singanaguttapalle village (Long. 77° 48' 39" and Lat. 14° 53' 40'') on the western flank of a small hillock and the other, approximately two and a half miles west of Mutchukota village. Asbestos mineralization is noticed at a place about half a mile south-east of Singanaguttapalle village.

In one of the steatite mineralization zones (near Singanaguttapalle), the Vempalle limestone belt is altered to a hard, compact and granular rock of serpentinous material. Alteration does not seem to be complete as shown...
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by faint-banded structure of calcareous material. Here, steatite occurs as discontinuous bands and also as enclosed bodies. In the steatite zone near Mutchukota village, the altered limestone is light-green to dark-green in colour, the dark-green type having an easy and perfect cleavage. Both the altered limestone and pure steatite show foliated structure. Steatite occurs here as continuous bands. In the asbestos mineralization zone, limestone shows complete alteration. The altered rock shows yellowish-green, light-green and dark-green colours with occasional granular structure. Asbestos fibre is in the form of veins cutting the altered rock.

EXPERIMENTAL WORK

The apparatus used for the present work is a portable unit of O-kay type manufactured by Bysakh & Co., Calcutta. Description of the apparatus and the procedure adopted were given by Sarma (1960). Samples selected for the present study are altered rocks from the steatite and asbestos zones of hydrothermal alteration. Samples Nos. V4/16 (a), V4/16 (b), V4/14, V4/17, V4/11 (b), V4/12 and V4/8 are from the Singanaguttapalle asbestos zone. Samples Nos. V3/3, V3/4 and V3/5 are from the Singanaguttapalle steatite zone and samples Nos. V1/3, V1/1, V1/4 and V1/5 are from the Mutchukota steatite zone.

RESULTS

The differential thermal curves of the samples are presented in Figs. 1 and 2. Sample No. V4/16 (a) gives a characteristic curve of serpentine with endothermic reactions having peaks at 120° C. and 660° C. and an exothermic reaction with a peak at 770° C. In the curve of sample No. V4/16 (b), the high-temperature exothermic reaction common for other serpentine samples is absent; and there is an additional endothermic reaction with peak at 780° C. This may be due to the presence of dolomitic molecule (Kulp et al., 1951). In the curve of sample No. V4/14, in addition to the usual endothermal and exothermal reactions characteristic of serpentine, there are two additional endothermal reactions with peaks at 740° C. and 780° C., characteristic of dolomite (Kulp et al., 1951). Samples V4/17 and V4/11 (b) show characteristic reactions of serpentine. The curve of the sample, V4/12, is similar to that of serpentine curve, with an additional high-temperature endothermic reaction with a peak at 780° C., which may be due to dolomite. The sample V4/8 shows, besides the reactions characteristic of serpentine, a small endothermic reaction between 880° C. and 940° C. with a peak at 900° C., which is due to calcite (Kulp et al., 1951).
FIG. 1. DTA Curves

FIG. 2. DTA Curves
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Sample V1/3 gives a curve different from that of serpentine. It shows two high-temperature endothermic reactions, with peaks at 600°C and at 750–800°C, and a broad exothermic reaction starting at 850°C and ending at 960°C, which are characteristic of chlorite mineral. This curve is quite comparable with the curve obtained by Bradley and Grim (1951) for prochlorite. Nagy (1954) obtained a DTA curve for clinochlore with two high-temperature endothermic reactions, with peaks at 650°C and 820°C, and an exothermic peak at 840°C. Curve of sample V1/1 shows an endothermic reaction with a peak at 870°C, which is characteristic of talc (Grito and Rowland, 1942; Bradley and Grim, 1951). V1/4 gives a curve showing two high-temperature endothermic reactions with peaks at 600°C and 780°C, characteristic of chlorite. This curve is slightly different from that of V1/3 in that this shows a third endothermal peak at 850°C. At this stage, doubt arises whether this additional reaction is due to calcite (or dolomite) or chlorite. The minor amount of calcium oxide, which is 0.67%, rules out the possibility that it may be due to calcite (or dolomite). It is therefore believed that this third reaction also is due to chlorite. The chemical composition of the sample SiO₂—44.73%, Al₂O₃—10.49%, Fe₂O₃—2.58%, FeO—0.92%, MgO—27.47%, CaO—0.67%, H₂O—12.70% suggests that the sample represents a pure chlorite mineral. This curve almost resembles that of prochlorite obtained by Bradley and Grim (1951), except for the absence of the high-temperature exothermic reaction. The sample V1/5 gives a curve showing endothermic reaction with a peak at 610°C, which may be due to chlorite. The intense endothermic reaction with a peak at 820°C may be due to calcite. The presence of 21.62% of CaO in its chemical composition supports this. The second endothermal reaction characteristic of chlorite is believed to have been suppressed by this calcite reaction which is more intense. A slight bend in the curve at 700°C is taken as an indication of the second reaction due to chlorite.

The samples V3/3, V3/4 and V3/5 give curves with characteristic reactions of serpentine. Samples V3/3 and V3/5, however, contain calcite as an impurity, evidenced by an endothermic reaction with peaks at 810°C and 850°C respectively in the two samples.

INTERPRETATION

The samples analysed fall into three groups on the basis of their thermal behaviour. They are (1) samples with high-temperature endothermic and exothermic reactions with peaks at about 660°C and 760°C respectively, characteristic of serpentine; (2) samples with the above reactions and also
some additional reactions due to impurities like dolomite and calcite; and
(3) samples showing successive high-temperature endothermic reactions,
characteristic of chlorite mineral. Samples from each of the three zones
(Singanaguttapalle steatite and asbestos zones and Mutchukota steatite
zone) show thermal behaviour distinctly different from the other two.
Singanaguttapalle samples from the asbestos zone show thermal reactions
characteristic of serpentine mineral. Both antigorite and chrysotile varieties
of serpentine have been reported to show high-temperature endothermic and
exothermic reactions (Syromyatnikov, 1936; Hess et al., 1952; Nagy, 1953;
Schmidt and Heystek, 1953). In general, the curves of all the serpentine
samples are closer to the chrysotile curves than to antigorite from the type
locality, Val Antigorio, Italy, which was investigated by Nagy and Faust (1956).

DTA curves of samples from Singanaguttapalle steatite zone also show
the characteristic reactions of serpentine; but the reactions are less
intense than in the above case, because of the partial serpenti-
nization. Impurities of dolomitic and calcitic molecule are present
in these samples. The curves of samples from Mutchukota steatite zone
show the absence of any thermal reactions characteristic of serpentine.
Instead, they show endothermal and exothermal reactions characteristic
of chlorite mineral. The essential difference in the thermal behaviour of
serpentines and chlorites is that in the former case, hydroxyl molecule is
expelled only at one stage, whereas in the latter case, it is expelled at two
stages. Though it is considered that minerals of chlorite species are res-
ponsible for the above characteristic curves, it is possible that the samples
may contain different species of chlorite as there are distinct differences in
the nature and temperature of the thermal reactions. Steatite sample gives
a characteristic curve of talc.

Summary and Conclusions

In the Vempalle limestone belt, steatite and asbestos resulted due to
hydrothermal alteration. The altered rocks, finally giving rise to these two
end-products, are distinctly different from one another. Samples of the
altered rocks from Singanaguttapalle asbestos and steatite zones and
Mutchukota steatite zone were subjected to differential thermal analysis.
Altered rocks from Singanaguttapalle asbestos and steatite zones contain
serpentine, but the latter are partially altered, whereas the former are com-
pletely altered. Altered rocks from Mutchukota steatite zone contain
chlorite but not serpentine. It is concluded from the results that in asbestos
mineralization, the intermediate alteration products are serpentines and that
the matrix of chrysotile fibre is essentially chrysotile variety of serpentine. In the steatite mineralization, the alteration products may be serpentine or chlorite. Initial composition and the nature of structural disturbance accompanying the intrusion of basic magma are supposed to determine the nature of the intermediate alteration products in the case of steatite.

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