THERMAL ANALYSIS OF CHROMITE ORES OF TAGADUR AREA, NUGGIHALLI SCHIST BELT, KARNATAKA, INDIA

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***Abstract**:* The Nuggihalli Schist Belt (NSB) is well known for its repository of chromite and magnetite reefs, which extends from Arasikere in the north to Kempinkote in the south. Important chromite deposits are found across Byrapur, Bhaktharahalli, Tagadur and Jambur areas of NSB. In the present investigation, emphasis has been laid to study chromite ores of Tagadur area using Thermogravimetric analysis-Differential thermal analysis (TGA-DTA). It has been well established that TGA-DTA provides most significant data on the thermal nature and behaviour of the important mineral ores. Results of the study indicated that Endothermic peaks for Quartz, Olivine and Chromite (spinel) as 227.53-250.17ºC, 814.90ºC and 834.04ºC respectively. The temperature range 837.66 - 910.35ºC corresponds to conversion due to dehydroxylation of Olivine and Spinel. In the same way, at different ranges of temperature, due to dehydroxylation and oxidation, conversion takes place to form new minerals. The curves obtained in this study match with the standard curves reported for chromite ores. However, there are negligible variations in the values in some samples because of accessory minerals and gangue. Therefore, the study indicates presence of chromite and associated minerals such as Magnatite, Magnasite, Enstatite, Amphibole, Chlorite, Serpentine and Talc from the Tagadur area.

Keywords: **Chromite, Tagadur, Nuggihalli Schist Belt (NSB), DTA, TGA, Karnataka**

I. INTRODUCTION

Chromite is the only ore of chromium metal and has a wide range of industrial applications. By nature it is mainly associated with iron owing to its chemical composition $FeCr_2O_4$. Chromite occurrence in Tagadur area is found as a band between peridotite and dunite. Tagadur village is covered in the Survey of India (SOI) Toposheet No. 57 C/8. Chromite occurrences in Karnataka are in ultrabasic rocks. It is black to brownish in colour and belongs to Spinel group of minerals. In this area, the schist belt stretches all over the area and rock types are very well exposed. Tagadur area is considered to be very unique for having ideal and characteristic rock types of ultramafic association, extensively developed with additional rock types which are uncommon in and around Byrapur area. Massive amphibole derived from the metamorphism of eucrite-anorthosite occurs in two distinct bands: komatiitic picrite and albite. Further, four bands of titaniferous magnetite are also exposed. Massive serpentinite with a lot of siliceous ribbed material exposed in the area is very coarse and contains big plates of serpentine pseudomorphous after pyroxene. This is apparently derived from pyroxinite (Sudhakar, 1976). Previous studies have shown that Thermo Gravimetric Analysis-Differential Thermal Analysis (TGA-DTA) is most reliable and rapid method to analyse the chemical and thermal behaviour of any mineral ores. Wherein, weight reduction as a consequence of rising temperature indicates the mineral behaviour. In the process of heating, change occurs in the substance and heat energy is liberated, the rate of reaction will enhance because of exothermic reactions. A total of five representative samples from Tagadur area were collected and subjected to thermal analysis to study its thermal behaviour at different temperature.

II. MATERIAL AND METHODS

Differential Thermal Analysis (DTA) it is a technique in which the temperature difference between a substance and a reference material is measured as a function of temperature whilst the substance and reference material are subjected to the same controlled temperature. Here this technique requires the use of a reference material, which is a known substance, usually inactive thermally (inert material) over the temperature range interest. Most important feature of the reference material is its thermal characteristics and the particle size should be finely powdered. The DTA method is useful in identification of the minerals which undergo transformation when heated to temperatures generally below 1400^0C. This method is suitable for both qualitative and semi-qualitative studies of minerals which liberate or absorb energy on heating results in transformations such as dehydration, dehydroxylation, oxidation, decomposition and phase changes.

The TGA technique is used to study the weight loss of a substance when it is being heated. The applications of the DTA methods are various and having been used in mineralogy. In many cases the TGA curve may be related to DTA curve of the corresponding mineral. The loss of weight of known amount of powdered sample is noted by heating up to the temperature of 1400ºC, each time for a period of 15 minutes at a regular interval of 100ºC. A 0.5 gm of powder has been used and the percent weight loss is being calculated and plotted on the graph.

III. RESULTS AND DISCUSSION

Thermal analysis was carried out employing TGA-DTA (make SDT Q600 V20.9 Build 20 TA). In this the distinction in the temperature with respect to a thermally idle material were estimated during the heating and the cooling of the sample. In the present investigation, aim has been to characterize the thermal bends of the chromite minerals and to consider how the technique can be connected to the natural or regular mixtures. Total five samples were subjected to DTA and TGA analysis and the results are discussed below for respective samples. Further, a brief description about the sample name, type of reaction, minerals identified and nature of chemical reaction are tabulated in Table 1 and 2.

3.1 Differential Thermal Analysis (DTA)

Table 1: Results of Differential Thermal Analysis (DTA) of different chromite ores from Tagadur area

Sl. No	Sample	Endothermic peak (ºC)	Minerals Identified	Nature of reaction
1	L-03	227.53-250.17ºC 814.90ºC 834.04ºC	Quartz, Olivine and Spinel	Dehydroxylation
2	L-06	88.22-159.70ºC 936.09ºC	Quartz, admixture of Magnetite, Olivine and Spinel	Dehydroxylation (At higher temperatures). Dehydroxylation (Continues in the immediate formation of iron and silicon that transform subsequently into crystalline hematite, Olivine and Cristobalite, while the more aluminous sample forms $FeAlO_3$ and Mullite as well)
3	L-13	743.36-768.76ºC	Chrome chlorite	Oxidation (Due to oxidation of bivalent iron)
4	L-15	783.19-985.33ºC	Magnetite and Chromite	Oxidation
5	L-16	646.69-839.95ºC 1096.41-1286.50ºC	Amphiboles Cristobalite and Mullite	Dehydroxylation (Recrystallization to Cristoballite, and Mullite)

1] Sample No. L-03

The DTA curve of the sample shows (Fig. 1) a gradual endothermic depression at 227.53ºC to 250.17ºC. This matches with the curve given in the literature for Quartz. Endothermic depression observed at 814.90ºC corresponds to Olivine. Endothermic depression observed at 834.04ºC corresponds to the formation of curve given in the literature for Spine [1].

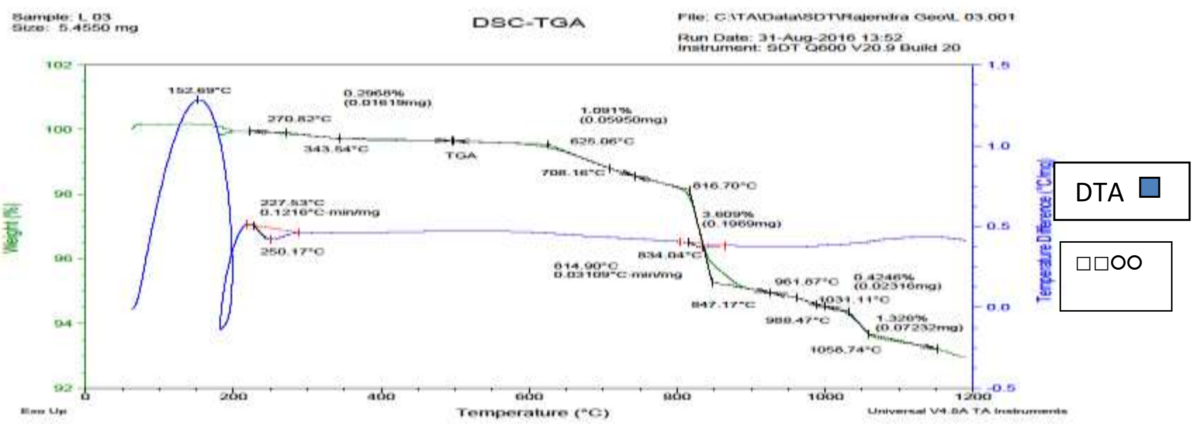

Fig. 1 DTA curve for sample no-1 (L-03)

2] Sample No. L-06

The DTA curve of the sample shows (Fig. 2) an endothermic peak around 88.22 ºC to 159.70 ºC and peak around 936.09 ºC which depicts the presence of Quartz, Olivine and Spinel.

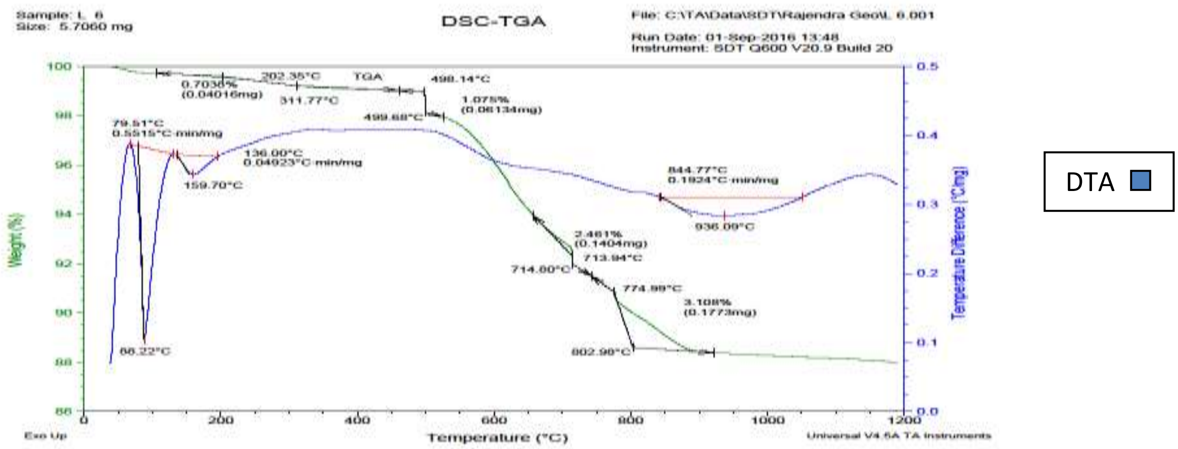

Fig. 2 DTA curve for sample no-2 (L-06)

3] Sample No. L-13

The DTA curve of the sample shows (Fig. 3) an endothermic peak around 743.36 ºC to 768.76 ºC depicts the presence of Chrome chlorite.

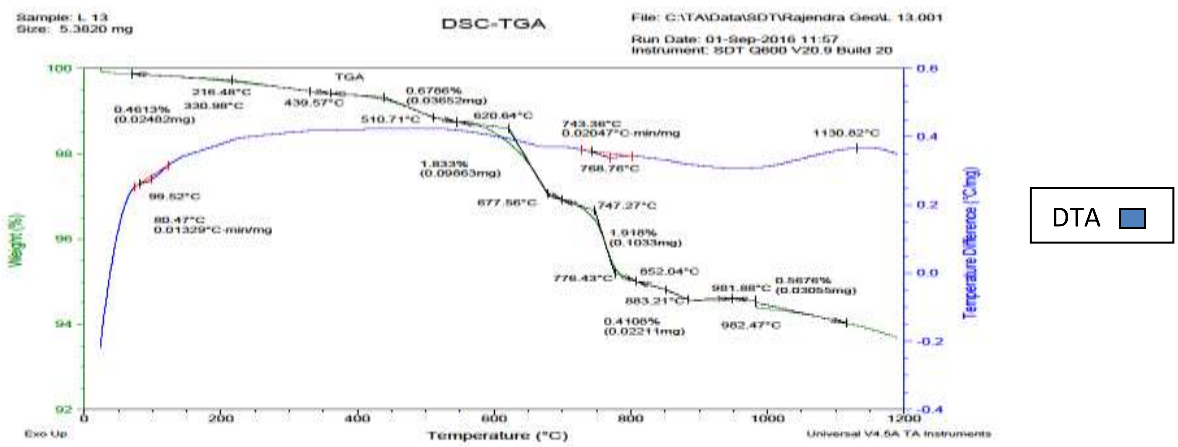

Fig. 3 DTA curve for sample no-3 (L-13)

4] Sample No. L-15

The DTA curve of the sample shows (Fig. 4) an endothermic peak around 783.19ºC to 985.33ºC depicts the presence of Magnetite and Chromite[1].

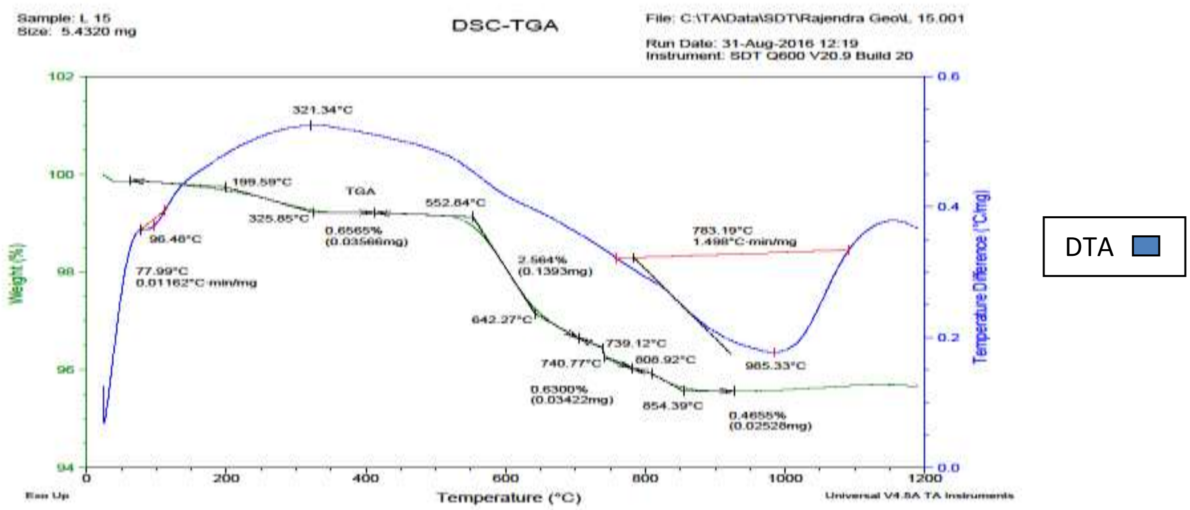

Fig. 4 DTA curve for sample no-4 (L-15)

5] Sample No. L-16

The DTA curve of the sample shows (Fig. 5) an endothermic peak around 646.69ºC to 839.95ºC depicts the presence of amphiboles and an endothermic peak around 1096.41ºC-1286.50ºC depicts the presence of Cristobalite and Mullite.

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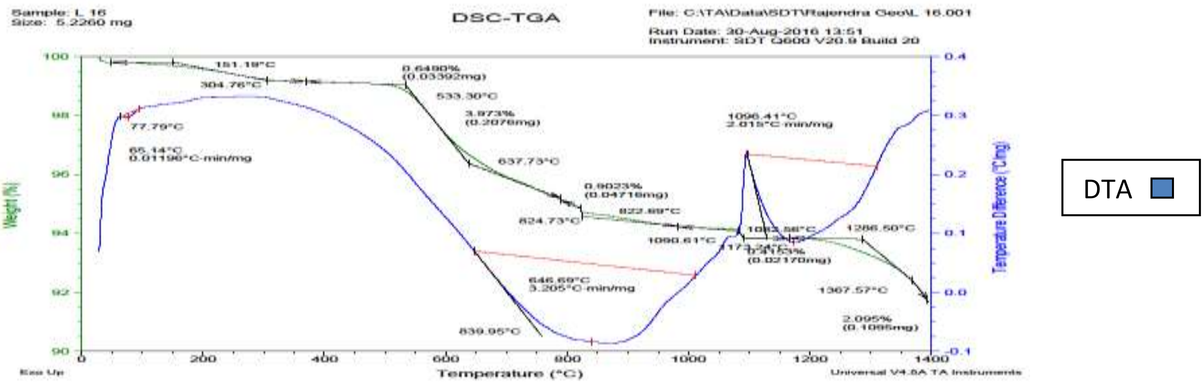

Fig. 5 DTA curve for sample no-5 (L-16)

3.2 Thermo-Gravimetric Analysis (TGA)

Thermo-Gravimetric Analysis (TGA): The TGA curves of the samples are shown in the figures the results of the samples are tabulated in (Table 2).

Table 2: Thermo-gravimetric analysis (TGA) of chromite ores from Tagadur area

Sl. no	Sample	Loss of Weight (%)	Temperature (°C)	Corresponding minerals identified	Nature of chemical reaction
1	L - 03	3.609	625.06-816.70°C	Quartz, Olivine and Spinel	Dehydroxylation
2	L - 06	3.108	202.35-802.98°C	Quartz, admixture of Magnetite, Olivine and Spinel	Dehydroxylation
3	L - 13	1.918	216.48-776.43°C	Chrome chlorite	Dehydroxylation
4	L - 15	2.564	199.59-642.27°C	Magnetite	-
5	L - 16	2.095	824.73-1367.57°C	Cristobalite and Mullite	-

1] Sample No. L-03

The TGA curve of the sample shows (Fig. 6)a gradual weight loss up to 816.70^{0}C. The rate of loss of weight is increased rapidly from temperature range 625.06ºC to 816.70ºC (3.609 %), which corresponds to the temperature where Olivine is transformed to Chromite (Spinel)[1].

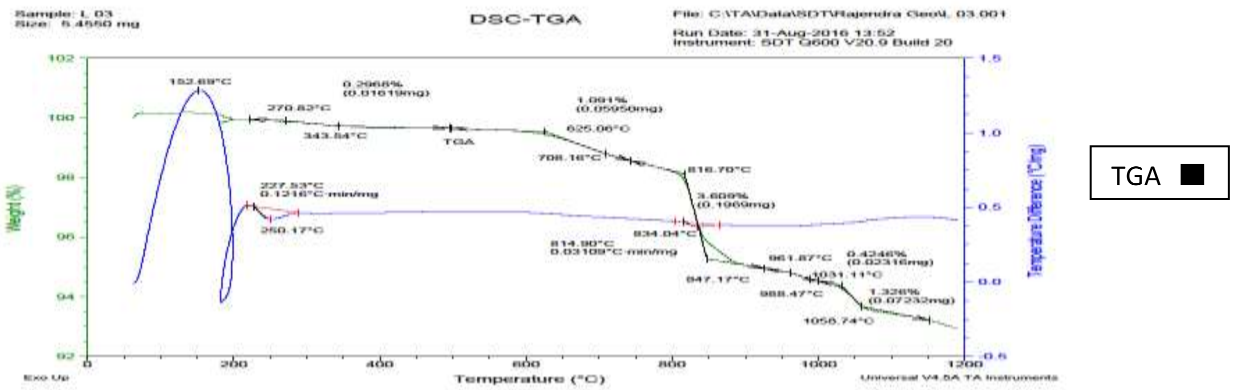

Fig. 6 TGA curve for sample no-2 (L-03)

2] Sample No. L-06

The TGA curve of the sample shows (Fig. 7) a gradual weight loss up to 802.98ºC. The rate of loss of weight is increased rapidly from temperature range between 202.35 to 802.98ºC (3.108 %), which corresponds to the temperature where Quartz, admixture of Magnetite is transformed to Olivine and Spinel [1].

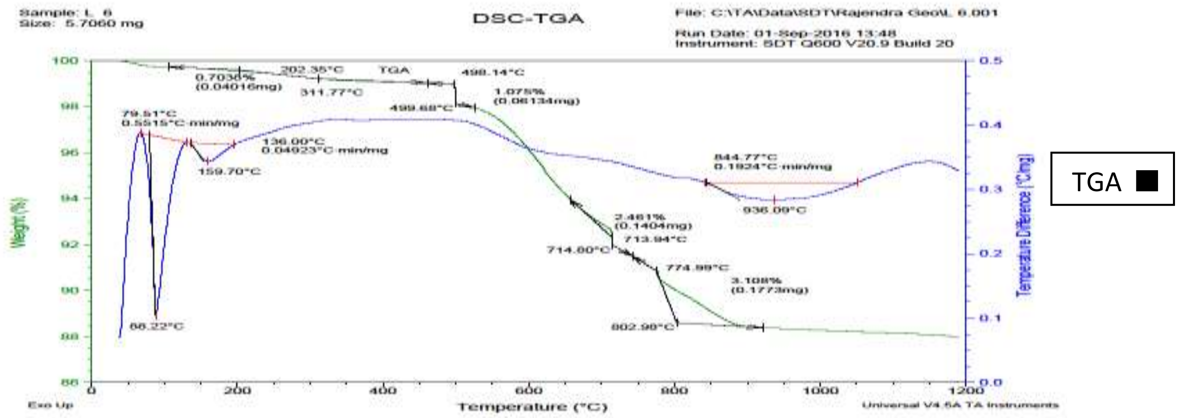

Fig. 7 TGA curve for sample no-2 (L-06)

3] Sample No. L-13

The TGA curve of the sample shows (Fig. 8) a gradual weight loss up to 776.43ºC. The rate of loss of weight is increased rapidly from temperature range 216.48-776.43ºC (1.918 %), which correspond to the temperature where chrome chlorite is formed, due to dehydroxylation [1].

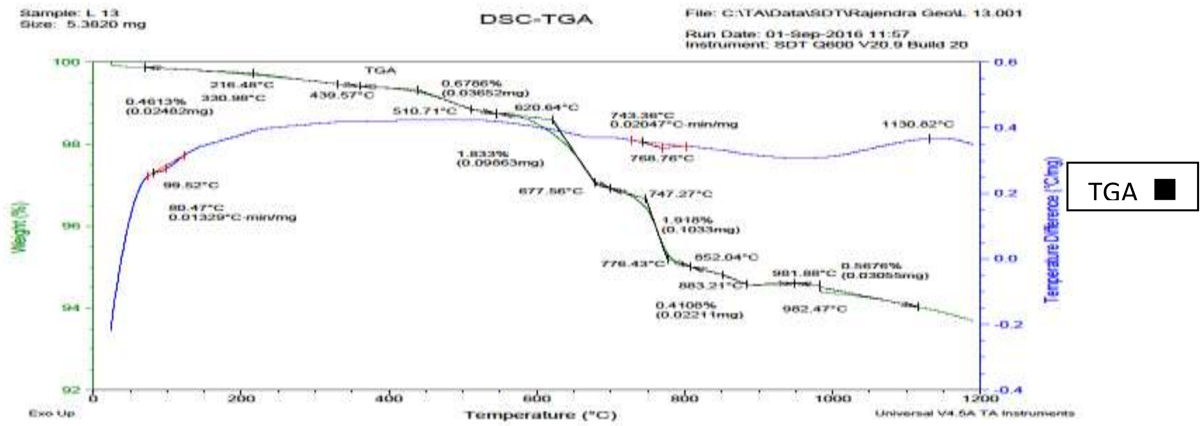

Fig.8 TGA curve for sample no-3 (L-13)

4] Sample No. L-15

The TGA curve of the sample shows (Fig. 9) a gradual weight loss up to 642.27ºC. The rate of loss of weight is increased rapidly from temperature range 199.59-642.27ºC (2.564 %), which corresponds, to the temperature where magnetite is transformed to form Chromite due to Oxidation [1].

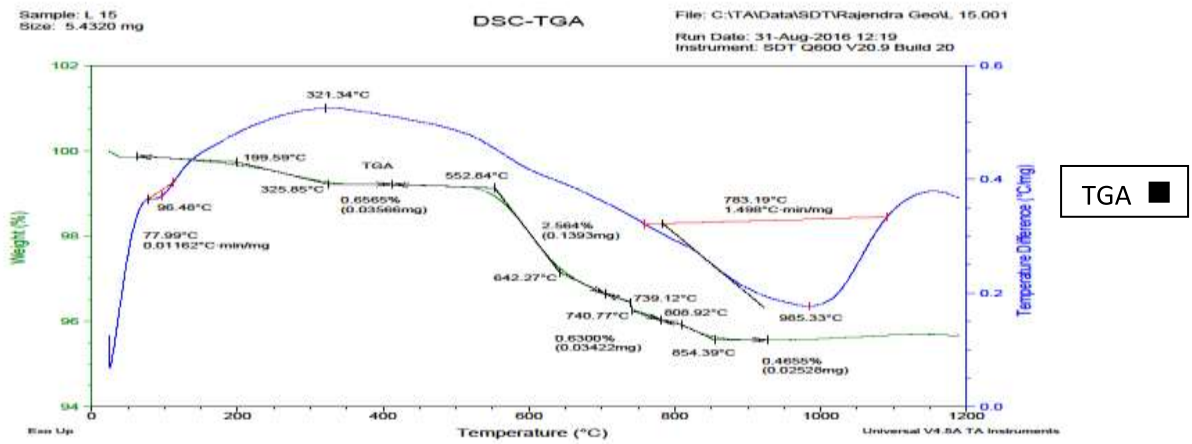

Fig.9 TGA curve for sample no-4 (L-15)

5] Sample No. L-16

The TGA curve of the sample shows (Fig.10) a gradual weight loss up to 1173.24ºC. The rate of loss of weight is increased rapidly from temperature range 533.30-1173ºC (0.4153 %), which corresponds, to the temperature where amphiboles are transformed to Cristobalite and Mullite [1].

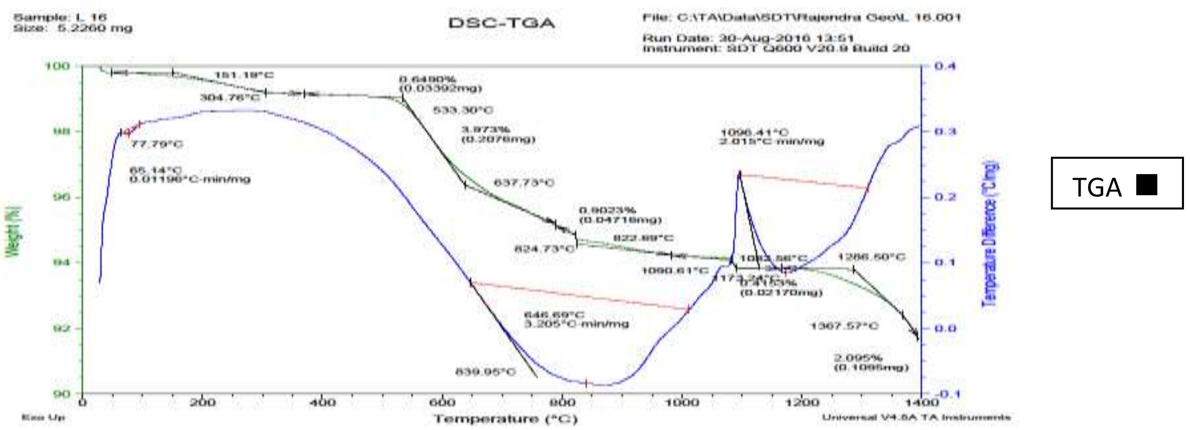

Fig.10 TGA curve for sample no-5 (L-16)

IV. CONCLUSIONS

The results of Differential Thermal Analysis (DTA) and Thermo Gravimetric Analysis (TGA) for samples of Chromite ores of Tagadur area revealed, endothermic peaks for Quartz, Olivine and Chromite (spinel) were noted at 227.53 - 250.17ºC, 814.90ºC and 834.04ºC respectively. The temperature range from 837.66 - 910.35ºC corresponds to conversion due to dehydroxylation of Olivine and Spinel. In the same way, at different ranges of temperature due to dehydroxylation and oxidation conversion takes place to form new minerals. Some of the minerals identified in the study area include- Magnatite, Magnasite, Enstatite, Amphibole, Chlorite, Serpentine and Talc which have been obtained referring standard curves for chromite ores. However, slight variations in the results were also observed which may be attributed to presence of minor components such as accessory minerals and gangue.

V. ACKNOWLEDGEMENTS

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