JOURNAL GEOLOGICAL SOCIETY OF INDIA
Vol. 31, May 1988, pp. 499 to 503

TITANOCLINOHUMITE FROM ULTRABASIC ROCKS OF SALEM, TAMIL NADU

B. MANJUNATHA REDDY AND A. S. JANARDHAN
Department of Geology, University of Mysore, Manasagangotri, Mysore 570006

Abstract

The optical and chemical characters of titanoclinohumite occurring in the serpentinised dunites of Salem are described. The association of the mineral with serpentine veins and mobilised veins points to its secondary origin. Temperature of titanoclinohumite formation is estimated around 450–500°C based on indirect approach of olivine-spinel thermometry.

Introduction

The ultrabasic rocks of Salem are well-known for their large magnesite deposits and rare association of alkali-ultrabasic rocks (shonkinites). These ultrabasic rocks occur at the intersection of two major NE-SW and EW lineaments. These rocks have been receiving considerable attention regarding their origin, mode of occurrence and relation to Proterozoic tectonics.

Titanoclinohumite, a rare mineral, has recently been reported from ultrabasics of Salem by Murthy (1979). Titanoclinohumite is known to occur in mantle derived kimberlites and ultrabasics by Aoki *et al.* (1976) and Trommsdorff and Evans (1980). Kutty *et al.* (1986) have discussed the origin of ultrabasic and associated grabbroic rocks of Salem based on the assumption that the titanoclinohumite is a primary mantle-derived mineral.

The authors, while working on the Salem ultrabasics and associated shonkinites, found the occurrence of titanoclinohumite in several localities. The presence of this mineral in ultrabasics, particularly if it is of primary nature, could have great implications for the nature of the mantle which gave rise to the Salem ultrabasics. In this paper, the field occurrence, petrography, chemistry and the origin of these titanoclinohumite occurrences are discussed.

Geology

Two bodies of magnesite-bearing dunites near Salem in Tamil Nadu, are emplaced into the Archaean charnockite terrain and are disposed along ENE direction in an en-echelon pattern. Both the ultrabasic bodies are serpentinized but the degree of serpentinization is higher in the smaller body. Gabbroic-textured alkali-ultrabasic rocks (shonkinites) occur extensively as cross-cutting intrusives in the northern ultrabasic belt and also as small lenses along the margins of both the dunite bodies. Magnesite mineralisation in dunites post-dates the intrusion of shonkinites. Magnesite is persistent to depths of 300 m below MSL as revealed by borehole data.

Titanoclinohumite is always associated with serpentine veins and along minor fractures filled with serpentine. Significant quantities of reddish-pink titanoclinohumite occur as granular aggregates as well as discrete tabular crystals embedded in the matrix of green lizardite (Plate I a and b); further, at places, 1-1½ cm thick bands of titanoclinohumite are seen in serpentinized dunites. Granular aggregates of peppery chromite and books of cleavable dark-greenish talc occur along with this mineral (chromite and talc have been identified by XRD).

0016-7622/88/31-5-499/$ 1.00 © Geol. Soc. India.

Petrography and Chemistry

Petrographic study reveals that the titanoclinohumite occurs as tabular and subrounded grains; tabular grains are invariably surrounded by a thin fringe of fine-grained material. Titanoclinohumite is very fresh, strongly pleochroic, X-pink, Y-pinkish-yellow and Z-golden-yellow, α: Z is 5-8° and $2V_\gamma = 78°$. A few grains show lamellar twinning and are seen growing from olivine grains (Plate Ic). In addition to titanoclinohumite, talc and carbonates, fibrous antigorite are also seen developing from olivine.

Talc is colourless in thin section, shows low relief, greyish interference colour and is intimately associated with fine-grained carbonates which are common throughout the thin section. Opaques (chromite) are generally irregular in shape.

Partial wet chemical analysis (Table I) of carefully separated titanoclinohumite mineral grains from both the ultramafic bodies show high TiO_2 and MgO, variable amounts of SiO_2, FeO and MnO with minor amounts of other oxides. There is a good comparison between the analysed mineral and that of titanoclinohumite reported in literature (Table I).

Chemistry of olivines and chrome spinels from fresh dunites of the area (Table I) have been utilised to calculate olivine-spinel thermometry, which shows that chromites have been re-equilibrated at low temperatures of 450–500°C, most probably by deep-seated hydrothermal solutions which gave rise to magnesite mineralisation.

Conclusion

The present occurrence has some similarities with the first reported titanoclinohumite from the kimberlites of Buell Park, USA (Aoki *et al.* 1976), which was considered to be a primary mantle-derived mineral. Later, Smith (1977), strongly felt that titanoclinohumite is a secondary one, as a phase in the hydrated assemblages of peridotite at below 700°C.

Our field investigations show that the alkali-ultrabasic gabbroic rocks (shonkinites), occur as intrusives into the dunites. Often xenoliths of dunite are found in shonkinites; with sharp contacts. Therefore, one is strongly tempted to link the titanoclinohumite formation to shonkinite intrusion. Further, Salem ultrabasics occur at the intersection of two major lineaments, which are the sites of extensive carbonatite-alkali-syenite-syenite intrusions. Thus, the presence of shonkinite and the carbonatite alkali-syenite association could have easily supplied the much needed titanium and fluorine for the formation of titanoclinohumite. Trommsdorff and Evans (1980) report that titanoclinohumite breaks down to olivine + magnesian ilmenite (geikielite) ± magnetite (at T > 520°C and at P of 3 Kbars). Titanoclinohumites in ultrabasics of Salem are fresh and no breakdown products have been

---

EXPLANATION OF PLATE I

a) 1½ cm thick vein of titanoclinohumite with serpentine in altered dunite.

b) Titanoclinohumite aggregates embedded in serpentine mat. (TCH = Titanoclinohumite, T = Talc, S = Serpentine).

c) Titanoclinohumite (orange-yellow coloured) growing on olivine. Note also drawn out, recrystallised chromite grains (opaque) (Ol = Olivine)

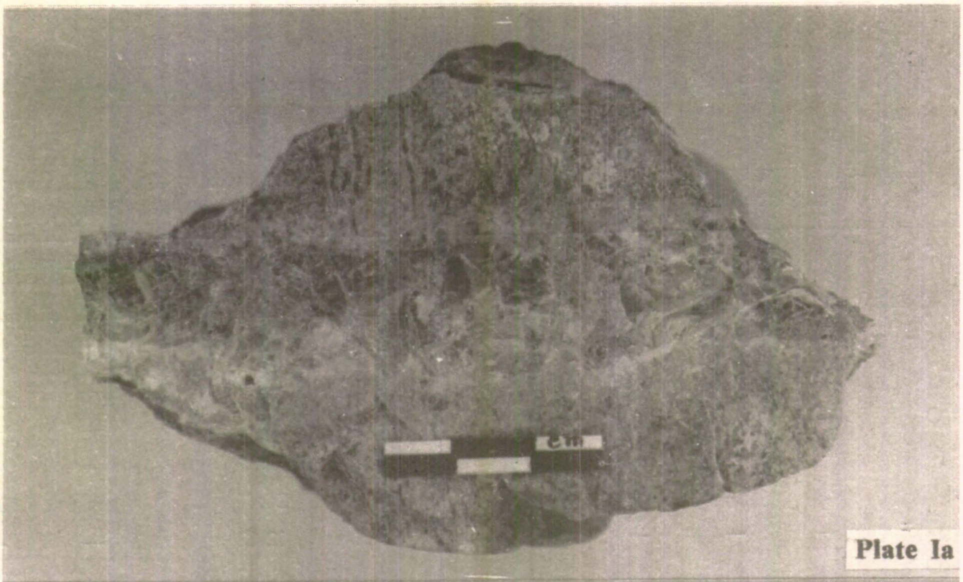

Plate Ia

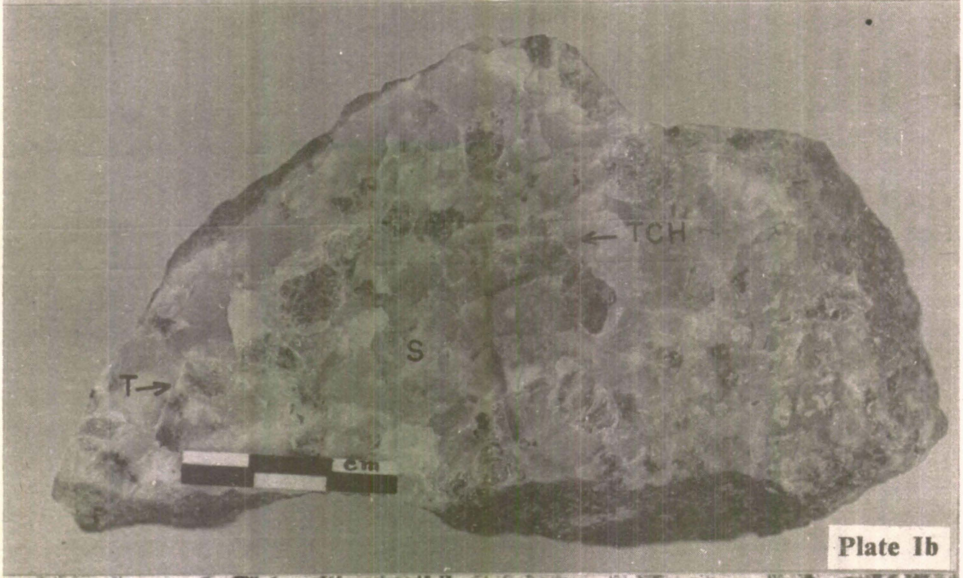

Plate Ib

Plate Ic

TABLE I.

	Chemical analyses of titano-clinohumite			Electron microprobe analyses of olivine and chromite in dunite of Salem			
				Chromite		Olivine	
	1	2	3*	MC_{13}	MSA_{15}	MC_{13}	MSA_{15}
SiO_2	36.59	47.41	35.61	—	—	41.36	41.02
TiO_2	5.27	4.88	4.83	0.53	0.60	—	—
Al_2O_3	0.15	0.09	0.01	6.72	6.51	—	—
Cr_2O_3	—	—	—	50.13	49.33	—	—
FeO	4.48	4.57	10.53	23.29	24.47	9.90	10.00
Fe_2O_3=	—	—	—	13.20	12.62	—	—
MnO	0.05	0.07	0.18	0.79	0.62	0.16	0.17
MgO	49.68	48.83	46.04	5.34	4.34	48.60	49.11
NiO	—	—	0.19	—	—	—	—
CaO	0.06	0.05	—	—	—	—	—
F	nd	nd	—	—	—	—	—
H_2O	2.69	2.84	1.92	—	—	—	—
Total	98.97	98.74	99.24	100.00	98.49	100.02	100.30

	Number of cations on the basis of 18 (O, OH, F)			Structural formula on the basis of 32 oxygens		Structural formula on the basis of 4 oxygens	
Si	3.915	3.996	4.000	—	—	1.011	1.002
Ti	0.424	0.392	0.408	0.1168	0.1365	—	—
Al	0.019	0.011	0.001	2.2023	2.1845	—	—
Cr	—	—	0.002	11.0115	11.0592	—	—
Fe^{+2}	0.401	0.408	0.980	5.4056	5.8197	0.202	0.204
Fe^{+3}	—	—	—	2.7696	2.6965	—	—
Mn	0.005	0 006	0.017	0.1835	0.1536	0.003	0.004
Mg	7.922	7.775	7.704	2.2023	1.8432	1.771	1.788
Ni	—	—	0.017	—	—	—	—
Ca	0.007	0,006	—	—	—	—	—
OH	1.919	2.023	—	—	—	—	—
$\frac{100\,Mg}{Mg+Fe}$				28.75	24.05	89.76	89.75
$\frac{100\,Fe^{+3}}{Fe^{+3}+Al+Cr}$				17.33	16.92		

1 =from smaller ultramafic body (Southern belt)

2 =from bigger ultramafic body (Northern belt)

3* =from Buell Park, Arizona USA (after Aoki *et al.* 1976)

=Total iron analysed as FeO, Fe_2O_3 is calculated on the basis of spinel stoichiometry.

noticed, and further it is seen developing from olivine. Thus the titanoclinohumite must have formed at T of 450-500°C and at shallow depths.

Acknowledgements : The authors acknowledge with thanks the facilities provided by Prof. V. Venkatachalapathy. BMR gratefully acknowledges the UGC (SAP) for financial support.

References

AOKI, K. I., FUJINO, K. and AKAOGI, M., (1976) Titanochondrodite and titanoclinohumite derived from the upper mantle in the Buell Park Kimberlite, Arizona, USA. Contrib. Mineral. Petrol., v. 56, no. 3, pp. 243-253.

KUTTY, T. R. N., MURTHY, S. R. N. and ANANTHA IYER, G. V., (1986) REE geochemistry and petrogenesis of ultramafic rocks of Chalk Hills, Salem. Jour. Geol. Soc. India, v. 28, pp. 449-466.

MURTHY, S. R. N., (1979) Petrology of the ultramafic rocks of the Chalk Hills, Salem, Tamil Nadu. Rec. Geol. Surv. India, v. 112, pt. 5, pp. 15-35.

SMITH, D., (1977) Titanochondrodite and titanoclinohumite derived from the upper mantle in the Buell Park Kimberlite, Arizona, USA. Contrib. Mineral. Petrol., v. 61, no. 2, pp. 213-215.

TROMMSDORFF, V. and EVANS, B. W., (1980) Titanian hydroxyl-clinohumite: Formation and breakdown in antigorite rocks (Malenco, Italy). Contrib. Mineral. Petrol., v. 72, no. 3, pp. 229-242.

(Received: July 7, 1987)