

## **Origin of titanite in metarodingite from the Zagros Thrust Zone, Iraq**

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### **ABSTRACT**

Three types of metamorphic titanite have been noted in a metarodingite pod within the tectonized and serpentinized peridotite portion of the Penjwin ophiolite sequence within the Iraqi Zagros Thrust Zone (IZTZ), northeastern Iraq. Type I metamorphic titanite occurs as subhedral to anhedral fine-grained disseminated crystals within chlorite that was formed during chloritization of biotite as a result of low-temperature ( $T = 330\text{--}340\text{ }^{\circ}\text{C}$ ) ocean-floor metamorphism or rodingitization of plagiogranite under a reducing environment. It is characterized by intermediate  $\text{Al}_2\text{O}_3$  (Avg: 3.61 wt%), high  $\text{FeO}_T$  (Avg: 0.89 wt%), and intermediate  $\text{TiO}_2$  (Avg: 34.7 wt%). Type II metamorphic titanite occurs as a thin rim around ilmenite and has high  $\text{Al}_2\text{O}_3$  (Avg: 4.8 wt%), intermediate  $\text{FeO}_T$  (Avg: 0.6 wt%), and low  $\text{TiO}_2$  (Avg: 33.7 wt%); it represents a reaction product between grossular and ilmenite, which resulted from an oxidizing high-pressure–high-temperature ( $P = 1.4\text{--}1.6\text{ GPa}$  and  $T > 750\text{ }^{\circ}\text{C}$ ) metamorphic event involving plagiogranite. Type III metamorphic titanite occurs as very coarse, highly fractured grains up to 0.5 mm, with inclusions of ilmenite, and surrounded by albitic plagioclase, analcime, and chlorite. This titanite is characterized by low  $\text{Al}_2\text{O}_3$  (Avg: 1.23 wt%), low  $\text{FeO}_T$  (Avg: 0.30 wt%), and high  $\text{TiO}_2$  (Avg: 36.98 wt%). It formed during extensive titanitization of ilmenite by a reaction with Ca-plagioclase during moderate pressure and temperature ( $P < 1.6\text{ GPa}$  and  $T < 750\text{ }^{\circ}\text{C}$ ) conditions, as a result of albitization of Ca-plagioclase in plagiogranite.

**Keywords:** Titanite, titanitization, plagiogranite, rodingite, albitization, chloritization