An experimental investigation of the Panzhihua igneous complex, SW China – Addressing the genesis of Fe-Ti-V oxide ore deposits

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The Late Permian Panzhihua layered gabbroic intrusion of SW China hosts one of the largest magmatic Fe-Ti-V oxide deposits within the Emeishan large igneous province and is coeval with a peralkaline granitic pluton. The largest oxide ore body is found at the base of the intrusion which is unlike other layered intrusions where the Fe-Ti oxide deposits are located in the uppermost portions. This study attempts to model the genesis of the Panzhihua layered intrusion, including the formation of the ore deposit by reconstructing the crystallization sequence of minerals from low and high pressure experiments. The starting composition used for the experiment is similar to high-Ti Emeishan basalt that resembles the theoretical parental composition of the Panzhihua intrusion. The low pressure experiments were conducted between 1312ºC and 1102ºC. The first mineral to crystallize is Cr-rich titanomagnetite at 1274ºC. Following are Fe-Ti oxides (ilmenite+titanomagnetite); clinopyroxene ($Wo_{39-52}En_{39-47}Fs_{8-16}$) at 1188ºC; plagioclase (An_{67-41}) and orthopyroxene (Mg# = 93-95) at 1162ºC. The high pressure experiment occurs between 1240ºC and 1050ºC. Fe-Ti oxide and clinopyroxene ($Wo_{41-54}En_{12-24}Fs_{28-41}$) appear together as the first phases at 1180ºC. Following is plagioclase (An_{57-38}) at 1050ºC. The results of both experiments indicate that the early crystallization sequence of the parental magma is dominated by Fe-Ti oxide and partially explain why the largest oxide ore deposits of the Panzhihua intrusion are found in the lowermost layers. The low temperature residual glass compositions in both experiments are enriched in SiO_2, Al_2O_3, Na_2O and K_2O; and depleted in TiO_2, FeO, MgO and CaO. However, minerals crystallize at lower temperature in the high pressure and consequently have less silicic (SiO_2 < 60 wt%) residual glass composition than that of the low pressure experiment (SiO_2 ≈72 wt%). The similarity between Panzhihua granite and low pressure residual glass suggests that the Panzhihua intrusion probably formed at shallow depth. Futhermore, the liquid-crystal evolution constructed from the low pressure experiment show that a parental magma similar to high-Ti Emeishan basalt can produce an early enrichment of oxide minerals and a silicic residual liquid via fractional crystallization.