Geophysical Research Abstracts,
Vol. 10, EGU2008-A-06837, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-06837
EGU General Assembly 2008

Titanomagnetite-ilmenite equilibrium: a new experimentally based model to estimate temperature and oxygen fugacity in basic magmatic rocks

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Although the titanomagnetite-ilmenite thermo-oxybarometer has been widely used to retrieve information on temperature and oxygen fugacity during magmatic and metamorphic processes, the available formulations yield unsatisfactory results, especially at high temperature and low to moderate oxygen fugacities, i.e. in conditions relevant to crystallisation in basic rocks. We present a new version of this thermo-oxybarometer based on numerical fits of a large experimental data set comprising new results in the Fe-Ti-Al-Mg-O system and those of literature studies.

Our new subsolidus experimental results at temperatures in the range 1100–1300˚C under low to moderate fO_2 conditions show that the addition of Mg and/or Al in the concentration ranges that are usual in Fe-Ti oxides from basic magmatic rocks can be accommodated by simple projections. We have taken advantage of this fact and performed numerical fits to generate empirical formulations. The experimental data set comprised our results (Lattard et al. 2005; Sauerzapf et al. 2008) and those of selected literature studies (e.g. Evans et al. 2006). With the resulting expressions we can retrieve temperature values from the projected mole fractions of the ulvoespinel and the ilmenite endmembers of Tmt-Ilm_{ss} pairs and fO_2 values from the Tmt composition and temperature. The present thermo-oxybarometer model is designed only for assemblages of titanomagnetite and hemoilmenite (with the R-3 space group) which equilibrated at high temperatures ($T > 700$˚C) and low to moderate oxygen fugacities. Test of our model by using the compositions of Tmt-Ilm_{ss} pairs in products of liquidus experiments conducted at known T- fO_2 conditions (literature data and new re-

sults) show that the calculated values reproduce the experimental ones within ± 70˚C, in most cases even within ± 50˚C. The estimates of the oxygen fugacity are mostly within ± 0.4 log units. This is a significant improvement compared to the previous models.

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