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Crystallization kinetics of clinopyroxene and titanomagnetite growing from a trachybasaltic melt: New insights from isothermal time-series experiments

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Nominally anhydrous (0 wt.% H_2O added) and hydrous (2 wt.% H_2O added) isothermal time-series experiments were performed at 400 MPa and NNO+2 buffering condition by heating at a rate of 80 °C/min a synthetic trachybasaltic glass from room temperature up to the superliquidus condition of 1,300 °C. This temperature was kept constant for 30 min and then decreased down to the target crystallization condition of 1,100 °C at a rate of 80 °C/min. The isothermal condition was kept constant over dwell times of 0.5, 1, 2, 4, 8, and 24 h. Then, an isobaric quench of 100 °C/s was applied. The resulting mineral assemblage always consists of clinopyroxene and titanomagnetite. Textural analysis reveals that the crystal size increases with increasing dwell time. Hydrous experimental products show crystal dimensions larger than anhydrous ones. A marked clinopyroxene maturation is evidenced with increasing experimental time and, consequently, the crystal habit changes from dendritic to euhedral. This phenomenon can be attributed to crystal coarsening and aggregation coupled with the resorption of early-formed dendritic branches of clinopyroxene. Coherently, the crystal size distribution of titanomagnetite shows an upward convexity and downturn at small crystal sizes, indicative of Ostwald ripening. To conclude, crystallization kinetics in trachybasaltic melts can be extremely fast due to the imposition of a thermodynamic driving force caused by a large degree of initial undercooling enhancing early nucleation. However, over a relatively short time, textural maturation occurs when crystal growth through attachment largely exceeds the nucleation rate.