NEW PALAEOPIEZOMETER AND ITS APPLICATION FOR ESTIMATION OF INJECTED ANORTHOSITE MAGMA PRESSURE

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A new palaeopiezometer has been designed and applied for estimation of magma pressure \( (P_m) \) during intrusion of anorthosites of the Geran massif (Ulkhan–Dzhugdzhur anorthosite–rapakivi granite complex, Aldan shield, Russia) \((1.73–1.70 \text{ Ga})\). This piezometer is based on the analysis of twin-density in crystals deformable plastically by mechanical twinning (e.g. plagioclases). Theoretical equation expressing the differential stress \( (s) \) as a function of the twin density \( (D) \) was obtained in the following form:

\[
s = XG \log[1 + Y(D/S) - Z(a_2/S)]
\]

Where:

\[
G = \text{shear modulus, } S = \text{shear magnitude (coefficient) for mechanical twins, } a = \text{average lattice parameter}
\]

\[
X = 4.75 \times 10^{-3}, Y = 0.345 \text{ mm}^{-1}, Z = 1.716 \text{ mm}^{-2} (X, Y, Z \text{ are constants, obtained from experimental data } s(D) \text{ for calcite twinning (cf. Rowe & Rutter 1990)}).
\]

Equation (1) was applied to palaeostress estimation for plagioclase-bearing rocks of the Geran anorthosite massif. The parameter \( D \) was measured for pericline and albite twins in plagioclase. The values of differential stress \( s \) were obtained using Eq. (1) for various samples: for anorthosites from the centre of the massif \( (s_1 = 0) \) and near the contact zone \( (s_2 = 211 \text{ MPa}) \), for granulite near the contact zone \( (s_3 = 291 \text{ MPa}) \), 1 km \( (s_4 = 257 \text{ MPa}) \) and more than 2 km away from the contact zone \( (s_5 = 176 \text{ MPa}) \). Errors of the differential stress values did not exceed 88 MPa. The absolute maximum of \( s \) was observed near the contact zone. The maximum may have been induced by injected anorthosite magma pressure \( P_m \), which was greater than lithostatic pressure \( P_l \) for granulite: \( P_m - P_l = s \). Using the well-known value for the \( P_l \), the estimation of the unknown magma pressure \( P_m \) was obtained:

\[
P_m = P_l + (s_3 - s_5) = P_l + s_2 = 0.8 \pm 0.1 \text{ GPa}
\]