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A microfabric study of the Jegłowa metaconglomerate, Strzelin Massif, SW Poland

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An olygomictic quartz metaconglomerate with subordinate white mica content crops out near Jegłowa, 40 km south of Wrocław in SW Poland. The rock is an L-tectonite composed of distinct strongly aligned prolate pebbles, which show a resemblance to dates. The pebbles are often densely packed only leaving some small space for a fine-grained quartz matrix.

Several hundreds of weathered-out pebbles were collected in the field and their long (X), intermediate (Y), and short (Z) axes were later measured with an electronic caliper. The equivalent radius of the pebbles falls in the range between 0.4 to 1.8 cm and its median yields 0.8 cm. The equivalent radius exhibits a skewed distribution with an asymmetry towards high values. However, the count of the small weathered-out pebbles is most likely severely distorted by a sampling bias. The histograms of the axial ratios show an approximately log-normal distribution. The geometric means of the X/Y, Y/Z and X/Z ratios are 2.6, 1.4, and 3.7, respectively. The axial ratios seem not to be dependent on the equivalent radius. Several pebbles characterized by varying k-values were sliced in the XZ plane and analyzed in thin sections. The pebbles are composed of polycrystalline quartz of 1.5 mm in diameter on average, however, sporadically reaching even up to 3.0 mm. There is no relationship between the mean area of the grains and either X/Z or k-parameter of the hosting pebbles.

Photographic images of large polished XZ & YZ sections of hand specimens were captured and redrawn to determine the shape and the spatial distribution of the pebbles. A subtle color tone difference and/or the presence of a dark substance between the pebbles and the matrix facilitated the recognition of the pebbles. Only unequivocally identified pebbles were used for the analysis. The geometric means of the X/Z and Y/Z ratios of the pebbles' cross-sections are ca. from 2.8 to 4.7 and from 1.5 to 1.8, respectively. The results are quite similar to the ones obtained for the weathered-out pebbles. Using various flavors of the Fry analysis, the axial ratio of the strain ellipse measured for the XZ sections reaches values up to 6.5 and in YZ sections up to 1.7. In our numerical experiment, a randomly oriented assemblage of oblate ellipsoids with X=1.5-4, Y=1.5-2 and Z=1 subject to a finite homogeneous strain of 4:1:1 shows a distribution of the X/Z ratio that is similar to the one measured for the weathered-out pebbles. This suggests that the observed variability of the final pebble shapes could arise as a result of one deformation episode, using a realistic pre-deformational pebble shape distribution.

Quartz grains show mainly foam texture locally disturbed by bulges and sutures and reveal undulose extinction. It indicates grain boundary area reduction as a main mechanism of recrystallization modified by bulging and subgrain rotation recrystallization. The measurements of the quartz optical axes are performed using a computer-aided microscopic technique, the manual U-Stage method, and electron back scatter diffraction (EBSD). These techniques enabled us to analyze mechanisms of nucleation and recrystallization of quartz grains constituting both pebbles and matrix. The investigated metaconglomerate is characterized by a domainal fabric. Matrix grains exhibit a strong caxis maximum centered near the Y axis of the finite strain ellipsoid indicating activity of the prism <a> slip system. A secondary maximum at an intermediate orientation between the Y and Z suggests additionally the operation of the rhomb <a> glide system. The c-axes of quartz crystals in the pebbles are predominantly spread in the X-Z plane with a maximum close to Z axis implying the activity of the basal <a> glide system. Secondary maxima suggest the operation of the prism <c>, rhomb <a> and the prism <a> slip systems.

In our tentative view, the concurrent presence of the distinctly different CPO patterns in the studied sample can be explained twofold: (1) by the CPO pattern of the pebbles inherited from a previous higher temperature deformation episode or (2) different rheological behavior of matrix and pebbles during the same deformation episode. Matrix grains, which recorded c-axis maxima mainly near Y axis of the finite strain ellipsoid, behaved as a relatively weak rheological phase, whereas those grains forming pebbles, which recorded mainly maxima near the edge of the diagram, acted as a relatively strong rheological phase. In both scenarios the contribution of a grain-size sensitive deformation mechanism such as diffusional creep could lead to a higher effective viscosity of the pebbles with respect to the matrix grains providing the mechanism for the early fabric in the pebbles to escape from obliteration

Estimation of temperature of deformation recorded by matrix and pebbles was possible by utilization of the TitaniQ thermometer. Ti concentrations was determined by electron microprobe and correlated with CL intensity as recently it was shown that the intensity of CL in quartz in the wavelength region 415 nm is proportional to the concentration of Ti. Consequently, it was possible to establish a link between microstructures observed in investigated metaconglomerate and temperature of its formation.