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The significance of fractures in Europe *Poster*

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Analytical modelling of geological fractures is now at an exciting stage. In view of the ever-mounting amount of fracture data available, and the need for a European overview of the state of the art, we correlate fractures from across the continent. In order to achieve relevant and meaningful statistics, the dataset of millions of entries was downsampled to filter out inadequate and irrelevant values. The resulting data[3] are the object of this study. For each fracture there exist measurements on the strike (s), dip (d), outcrop trace length or height (l) and aperture or thickness (a) (Fig. 1).

The data are: 1) An earthquake fracture (formed in the June 17th earthquake of M6.6 in the South-Iceland-Seismic-Zone) from a Pleistocene basaltic lava flow near Eyvik, South Iceland (s 163, d 90, l 30 m, a 0.47 m),

2) a calcite vein from a horizontal outcrop of limestone layer (Blue-Lias-Formation, Lower Jurassic), Kilve, Somerset Coast, Southwest England (s 095, d 73, l 2.1 m, a 0.0045 m), and

3) a joint from a vertical section in a quarry in sandstone (Solling-Formation, Middle Buntsandstein, Lower Triassic) from Bad Karlshafen, Central Germany (s 166, d 90, l 0.48 m, a 0.0025 m).

All the fractures are extension fractures. Although there is still some discussion about shear joints being sheared joints, but shear joints are shear nonsense. Whatever, the present fractures are extension fractures.

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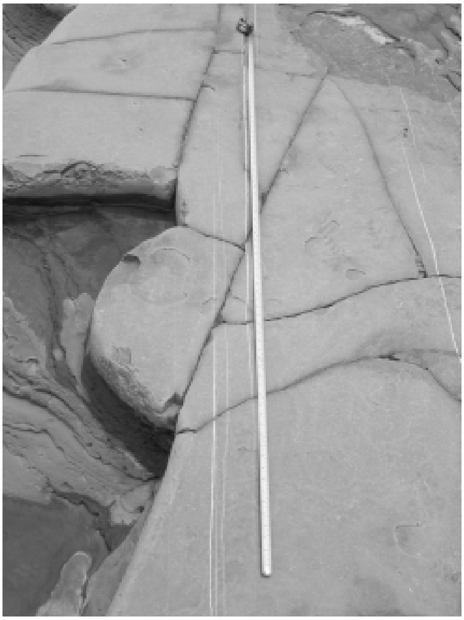

Figure 1: Measurement of the outcrop length l of data point 2 (see text)

Figure 2a shows the density contours of the strike and dip measurements in a Schmidt-net stereo projection (equal area, equatorial projection, lower hemisphere). The average fracture strike is 141.33 (N38.67W), the average dip is 84.33. From the strike direction we infer the orientation of the minimum principal compressive stress (maximum principal tensile stress), σ_3, as being 51.33°. The average aperture (thickness) of the fractures is 0.159 m; the average length is 10.86 m.

A scatter plot of aperture versus outcrop length (Fig. 2b) shows that the two variables are related to each other. Linear regression of the present data — with the aperture as the dependent variable y, the length as the independent variable x — results in the equation $y = 61.554x + 1.073$. The coefficient

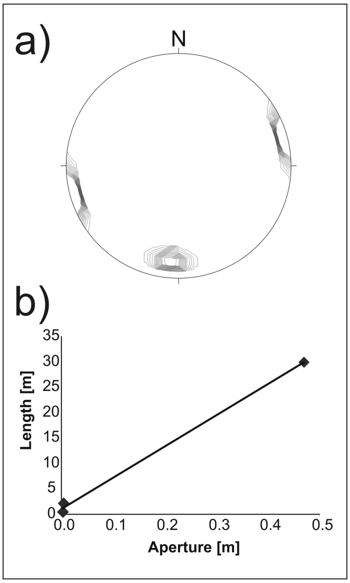

Figure 2: Meaningful presentation of our data. a) strike and dip density contours, b) scatter plot of aperture versus length)

of determination is $R^2 = 0.998$. With such a high correlation coefficient the correlation must be significant (but we would rather not run a statistical test with so few data points). This means that 99.8% of the variation in aperture is linearly related to the variation in outcrop length, and only 0.02% of the data variability cannot be explained by a linear regression.

We now use these data to calculate the fluid overpressure that formed these fractures (even if we do not know if they are hydrofractures, maybe they are, maybe not; the earthquake fracture from Iceland probably isn't, but who cares?). For a fluid-filled extension fracture modelled as a through crack there is a nice equation to calculate the static fluid overpressure (we don't present the equation here; we have the solution, it would not even be too long to print in this abstract, but we are too lazy to write all the symbols). And even if we don't care if the outcrop length is the controlling dimension, we still use this equation. For Young's modulus we use an average value of 79.157 GPa (based on an uneducated guess) and for Poisson's ratio a value of 0.2497 (ditto). Using the average aperture and outcrop length presented above, we obtain an average fluid overpressure of 617.99 MPa.

From this overpressure we can infer the depth to the source of the fluid that formed these fractures. Using an *in situ* tensile strength 579.7 kPa (yielding an upper limit for the excess pressure of the source rock and one fourth of the maximum differential stress), an average rock density of 2468 $\mathrm{kg\,m^{-3}}$ and an average fluid density of 975.12 $\mathrm{kg\,m^{-3}}$ (some water, some oil, some gas) we obtain a depth of 42000.10 m below the present surface.

This signifies that these fractures originated at depths somewhat greater than that of Moho beneath Europe, that is, in the lithospheric mantle. Extrapolating these significant results to the rest of our planet, it follows that there must thus be a lot of fluid in the mantle. Even if extrapolation to the moon, other planets, or beyond our solar system is maybe not valid, these results are not only significant but very important, and obviously extremely interesting.

Remarks

This work is not funded by anyone. Who should care about this nonsense? Anyway, we like doing field work in the sunshine. This is why we selected localities particularly in SW-England and Iceland ...

We could have written this text in Ger-

man. However, we felt that it sounds much more scientific in English, doesn't it?
The data presented here are original data from our field note books. The calculations are based on real equations that in fact are useful. The statistics and the conclusions presented here, however, are maybe not quite matching any scientific standards.