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Diffusion creep and localisation

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Diffusion creep is not normally thought of as a deformation mechanism which induces localisation, although zones resulting from localisation may deform by diffusion creep. However, new grain-scale numerical models for diffusion creep quite commonly show localisation in S and or C type structures formed by the alignment of grain boundaries into rather straight features on the scale of several grains. It is implicit in diffusion creep that slip occurs along grain boundaries. This has never been tested directly in geological materials but it is necessary to maintain strain compatibility. Moreover, it is implicit in the dependence of flow strength on grain size (cubic for grain boundary diffusion creep) that the shear stress along grain boundaries is small. The assumption of zero shear strength along grain boundaries is one of those incorporated in the numerical model (named "DiffForm") for diffusion creep. This background assumption allows some appreciation of why boundaries become aligned. If some alignment of boundaries is present, then non-aligned grains are, in a broad sense, asperities and subject to extra stress. Over time, then, they are dissolved away. This description is a simplification and is no substitute for watching the actual evolution of the numerical models; grain rotation is also an important contributor to the alignment.

Once aligned, the weak grain boundaries can take up most of the strain. The overall strength of the model rock decreases markedly during this localisation.