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Fault Related Quartz Cementation and Basin Scale Fluid Flow, Hopeman Sandstone, Scotland

Quartz cement is a major culprit of porosity loss in sandstones during deep burial. A major debate is whether mass-transfer can import quartz into the sandstone through exotic fluids, or if the cement is simply locally derived. This study reports asymmetric cementation around well-exposed faults, analogous to offshore North Sea structures.

The aeolian Permian (Hopeman) sandstone shows two normal cataclasite faults; the Clashach fault, with a 30m throw, and the Burghead fault, with c.100m throw. Seismic data reveals a 20 km long horst block at the edge of the 50km wide Inner Moray Firth Basin, which is analogous to several deeply buried offshore structural highs.

Quartz cement volume within the footwall increases toward each fault, rising from 5% at 70m, to 27% at 3m from the Clashach fault; porosity changes from 23% to 6%. The cementation pattern is asymmetrical across the fault plane; the adjacent hanging wall has an average of only 3% quartz cement and 22% porosity. The regional scale Burghead fault shows an even more pronounced relationship; footwall samples display up to 35% volume quartz cement 20m from the fault plane: porosity is less than 2%.

Aqueous fluid inclusion studies indicate the quartz cements precipitated from cool fluids around 60-70°C. Hydrocarbon inclusions, galena and fluorite are also present.

The structural high acted as a fluid exit point, draining a large basin area. Mass transfer of silica from the deeper basin caused shallow depth cementation. Fluid exit on the meso-scale was baffled by low permeability cataclastic fault planes.