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Origin of quartz cement in silcretes in the Fontainebleau sandstone: a study using infrared-microspectrometry, EBSD, CL and TEM

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Quartz cement in sandstones typically grows during burial at temperatures greater than about 90 deg C. However, the Fontainebleau sandstone in the Paris Basin, France, contains up to 25% quartz cement despite never being hotter than about 30 deg C. Thiry and Maréchal (2001) speculated that quartz cement in the Fontainebleau sandstones was a result of destabilisation of organo-silica complexes in an active groundwater system. This new study used a wide range of techniques including optical petrography, SEM-CL, back-scattered electron microscopy (BSEM), electron backscattered diffraction (EBSD), secondary X-ray analysis (EDAX), TEM and fourier transform infrared (FTIR) microspectrometry to study the origin of the quartz cement in the Fontainebleau sandstone. Petrography and SEM-CL revealed that the silica cements are subtly zoned. Much cement is fully euhedral although in some cases the cement and its zones have irregular isopachous rims that display 10 micrometer-scale CL zoning. The isopachous rims are optically isotropic and contain sub-micron sized inclusions. EBSD and EDAX revealed that all the cement is SiO2 although the isopachous rims contain layers that are not quartz but some other form of silica (Haddad et al., 2006). TEM confirmed that these isopachous rims contain non-crystalline, amorphous material. FTIR, using a Nicolet Centaurus microscope, was performed on doubly polished detachable wafers. Isopachous rims were revealed to be opal-A (amorphous opaline silica) having a (3700-3500) to (3500-3000) wavenumber ratio of 0.2 (Flörke et al., 2001). This confirms the EBSD and TEM analyses and shows that these layers contain silica with abundant structural Si-OH (silanol). FTIR also shows that these opal-A layers contain sub-micron inclusions that are filled with organic material dominated by hydrocarbon compounds. This work supports the Thiry and Maréchal hypothesis

since opal-A could easily result from destabilisation of organo-silica complexes in groundwater. Moreover the hydrocarbon inclusions associated with the opal-A, identified by FTIR, plausibly might be remnants of the organic material that complexed the silica.

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