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DIAGENESIS OF UPPER JURASSIC CONCRETIONS FROM THE ANTARCTIC PENINSULA

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**ABSTRACT**: Early-diagenetic calcite concretions are widespread in mudstone--tuff sequences deposited in Late Jurassic oxygen-deficient basins of the Antarctic Peninsula. Although obscured or destroyed in host rocks, original components and sedimentary structures are well preserved in concretions, in spite of significant mineralogical and geochemical change during growth. Early diagenesis led to a rapid and almost total variation in the mineralogy within the concretions, independently of the original host lithologies. Siliceous particles were replaced by chlorite and zeolites in suboxic, alkaline, and moderately reducing conditions on the sea floor and in the first centimeters of burial. These conditions also led to localized early formation of phosphate concretions. Pyrite developed subsequently because of high sulfide abundance in the sulfate reduction zone. Most calcite precipitation took place in the lower part of the sulfate reduction zone in a strongly alkaline environment where sulfide content had been lowered by pyrite precipitation. In this stage, the remaining siliceous elements were dissolved or replaced by calcite. Later diagenetic changes include enlargement of zeolites, minor changes in clay minerals, and the formation of calcite veins. The wide range of (13C values in cement and vein calcite (-1.47% and -20.23% PDB) is explained by mixed carbon sources from organic matter oxidation and dissolution of calcareous shells. The low (18O of calcite (-2.34% to -19.72% PDB) is the result of recrystallization in contact with high-temperature diagenetic or hydrothermal fluids flushed through micro-fractures in the concretions, which also produced extensive vein formation.

**METHODS**

The composition of mudstones, tuffs, and concretions was determined by standard polarized microscope and X-ray diffraction. Chemical analysis was performed by X-ray fluorescence combined with emission spectrophotometry for Na and K, gas-volumetry for CO2, and loss of ignition at 1000°C for volatiles. EDAX was applied for semiquantitative chemical analysis of single minerals. Samples were polished and etched with acetic or hydrochloric acid and coated with gold or carbon for SEM observations. Relative content of some minerals was quantified (for details see Scasso and Bausch 1995). A routine determination for clay minerals (< 2 (m fraction) was performed, as described in Scasso et al. (1991).

Carbon and oxygen stable-isotope composition was measured with a Finnigan Mat 252 mass spectrometer connected to an on-line carbonate preparation device (Carbo-Kiel) at the University of Erlangen (temperature of reaction = 75°C). Mean precision is ± 0.05% for (13C and ± 0.08% for (18O. Sulfur stable isotopes in pyrite were determined in Göttingen University (Germany). Archive tables 1 to 5 show size, compaction, and chemical and isotopic composition of the concretions.

**ARCHIVE MATERIAL:**

[**Table A1**](http://www.sepm.org/jsr/data_files/2001_data/tablea1.doc)**:** Measurements of some well exposed calcite concretions at Longing Gap; c = greatest lateral diameter [cm]; a = maximum thickness [cm]; D = discoidal type, T = tabular type. Compaction refers to the compaction of the matrix in relation to the concretion body.

[**Table A2**](http://www.sepm.org/jsr/data_files/2001_data/tablesa2_a3.xls)**:** Chemical composition of mudstones (M) and mudstone concretions (MC). TA = Nunatak Tres Amigos, Sobral Peninsula; SOB = Nunatak el Manco, Sobral Peninsula; FA, LO, LOGP = Longing Gap; GD, A, B = Sharp Valley glide block. DE = Calculated dilution effect through carbonate precipitation. The values printed in bold correspond most closely with the actual concentration in concretions. Confidence interval from t-distribution test.

[**Table A3**](http://www.sepm.org/jsr/data_files/2001_data/tablesa2_a3.xls)**:** Chemical composition of tuffs (T) and tuff concretions (TC). TA = Nunatak Tres Amigos, Sobral Peninsula; SOB = Nunatak el Manco, Sobral Peninsula; FA, LOGP = Longing Gap; GD = Sharp Valley glide block. See table 2 for further details.

[**Table A4**](http://www.sepm.org/jsr/data_files/2001_data/tablea4.xls)**:** EDAX analysis on different components of the concretions. SOB = Nunatak el Manco, Sobral Peninsula; K, LG = Longing Gap; GD = Sharp Valley glide block. LI = Byers Peninsula, Livingston Island.

[**Table A5**](http://www.sepm.org/jsr/data_files/2001_data/tablea5.xls)**:** Stable-isotope (13C and (18O (PDB) values in concretions. Sample reference: TA = Nunatak Tres Amigos, Sobral Peninsula; SOB = Nunatak el Manco, Sobral Peninsula; FA, L, X2, X9 = Longing Gap; GD, A, B = Sharp Valley glide block. LI = Byers Peninsula, Livingston Island. Lithologic reference: MC = Concretion on mudstone; TC = Concretion on tuff; MTC = Concretion on tuffaceous mudstone; FS = Fossils. Values in the right part of the table are from Ditchfield et al. (1994); AMM = ammonites; BEL = Belemnites; ARC = Arctotis; RETR = Retroceramus; UN = Unidentified fossil. T corresponds to the paleotemperature of formation of concretions calculated for pore solutions with a composition similar to that of the Upper Jurassic sea water ((w = -1.0% SMOW) and an oxygen isotope equilibrium fractionation expressed by: T = 16.9 -4.21 ((c - (w) + 0.14 ((c-(w)2 (Irwin et al., 1977); (c=(18O (PDB) and (w = (18O (SMOW).