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The role of macro-biological activity in the origin of grain-coating clays

S.J.Needham, R.H. Worden

Department of Earth and Ocean Sciences, University of Liverpool, 4 Brownlow St., Liverpool L69 3GP, UK (sneedham@liv.ac.uk / 0044 151 794 5184)

Using controlled experiments that simulate interlayered sand and mud in marine conditions, it is shown that clay-rims develop on sand grains during the digestive processes of the polychaete worm *Arenicola marina*. The mud minerals also undergo accelerated weathering and mineral authigenesis. Previously characterized synthetic mud (crushed slate) and clean, aeolian sand were horizontally layered in experimental and control tanks. Artificial seawater was added to this tank along with *A. marina*. Faecal casts were collected at regular intervals and these were analysed texturally using SEM analysis and mineralogically using X-ray diffraction and infrared spectroscopy. Over a period of many months the synthetic mud proved to be unchanged in the control tank, but was significantly different in faecal casts from the experimental tank that contained the worm *A. marina.* The original minerals were degraded and new authigenic clay (bio-clays) formed. It is postulated that a combination of low pH and the biologically-active microenvironment in the guts of annelid worms may radically accelerate mineral dissolution and clay mineral precipitation processes during digestion. Total bioturbation of the sand and mud layering by *A. marina* was achieved after only eight weeks of feeding activity. Sand grains in the faecal cast had developed clay mineral rims, a feature absent in the original material and not found in the control tanks. Thin, composite, curvilinear structures, presumed to be detached clay-rims were produced, as well as faecal peloids. Thus excreted sand-sized primary grains were coated with a rim, or layer, of parallel oriented, fine-grained minerals that is a mixture of the degraded primary mineral assemblage and neoformed bio-clays. It is likely that mucous produced by the worms not only led to the aggregation of the fine grained material into faecal casts but also adhered the fine sediment onto sand grains thus creating clay mineral rims. In this case the solid part of the clay rim will be a

combination of the primary material (crushed slate) and the neoformed clay minerals. The biogenically-produced clay-rims described here strongly resemble infiltrated clay rims described in the literature suggesting that there may be problems in discerning the two mechanisms on textural grounds.