LATE PALEOCENE SPHERULES FROM THE NORTH SEA: PROBABLE SEA FLOOR PRECIPITATES - A SILVERPIT PROVENANCE UNPROVEN. J. Whitehead[1], D. Jutson[2], R.A.F. Grieve[3], and J. G. Spray[1].
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Introduction. Spherules 170 to 740 μm in diameter have been identified in drill cutting samples of Late Paleocene age from exploration and production wells drilled in the Danish sector of the North Sea. These spherule occurrences occur approximately 250 km to the NE of the Silverpit structure, which is an unconfirmed impact structure (Stewart and Allen, 2002). The close proximity of the spherule-bearing layer with the Silverpit event, and their occurrence at a stratigraphic level contemporaneous with the Silverpit structure are not inconsistent with the spherules having been derived by ejection from Silverpit. Here we describe the spherules from one of these locations (Dan MFB-4b: Lat.55˚28'10.4"North: Long 5˚8'1.5"East), in order to test whether they may be impactogenic. A discovery of spherules comprising fusion glass or quench crystallisation features is important, as it would be the first external evidence that the unusual Silverpit structural depression was formed by impact.

Sampled layer. The sampled spherule-bearing layer is located at the top of the Lista Formation within the top of the *A. augustum* acme biozone, and basal part of the C24r magnetostratigraphic zone. The thickness of the layer cannot be established accurately from drill cutting samples in the holes sampled here, but a comparative red spherule-bearing layer in a core taken from the E-8x (Tyra Field) 35 km to the northwest was 60 cm thick. This E-8x layer is biostratigraphically barren while the sediment above and below the layer is palnyologically diverse. This might suggest very rapid deposition of the E-8x layer. Unfortunately, the E-8x samples were taken for engineering purposes and have since been destroyed. The spherule layer is *in situ* at both sites and it appears to occur at the same stratigraphic level, widely over the Danish sector.

Sample preparation and analytical techniques. Spherules from a red/purple claystone from 7640-7660 feet deep in hole DAN MFB-4a were separated from the unconsolidated matrix by wet sieving. Spherules were photographed, then mounted and gold coated for surface analysis using the scanning electron microscope (SEM), then mounted in crystal bond, polished and carbon coated for internal analysis by energy dispersive spectrometry using the SEM, then extracted with methanol and analysed by X-ray diffraction techniques.

Results. Where broken, the spherules are seen to comprise a light coloured cream-whitish thin crust, with a slightly darker, greenish core. Of the 13 spherules studied here, nine are near-spherical with rounded margins, while the remainder are equant but have more irregular edges. The irregular faces are typically present in those spherules in which broken surfaces are observed. Hummocky surfaces are also locally present (Figure 1). No dumbell- or teardrop-shaped fragments accompany the equant spherules.

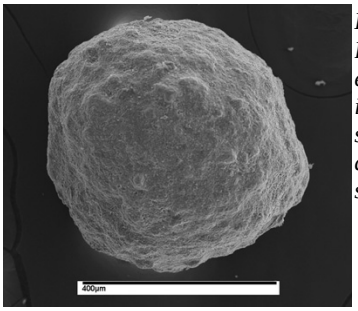

Figure 1 Backscattered electron image of a spherule with a hummocky surface.

X-ray compositional mapping and backscattered electron imaging indicates that the spherules are internally heterogeneous (Figure 2). They are neither glassy, nor do they contain quench crystallisation features, typical of impact-generated spherules. They predominantly comprise a Mn-Ca rich matrix with a typical grain size of ~5 to 10 μm, with clastic components of various minerals including quartz, alkali feldspar, rutile (or other TiO_2 polymorph), minor pyrite, muscovite and possible pyritised fossils. The clasts are typically between 5 and 20 μm in diameter, are angular and comprise ~5-10% of the volume of the spherules (i.e., they are matrix supported).

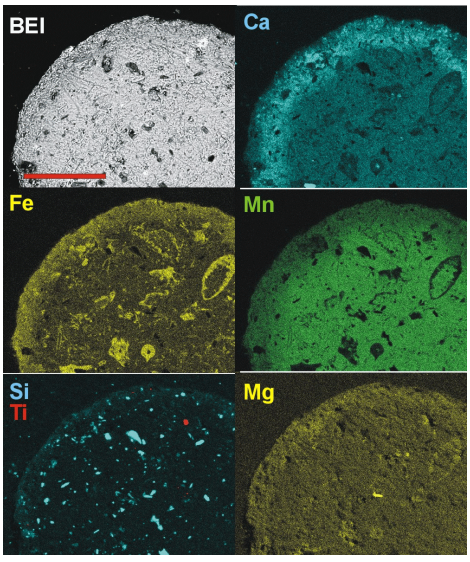

Figure 2 - Backscattered electron image (BEI) and X-ray compositional maps of spherule 8. Possible pyrite fossils are best defined by the Fe map. Scale bar is 100 um.

The margins of the spherules are depleted in manganese and are enriched in calcium, relative to the cores, to a depth of ~20 μm (Figure 2 and 3). This is probably a secondary leaching of manganese and/or addition of calcium from seawater.

Discussion. The occurrence of the spherules at a single stratigraphic level at two sites in the North Sea, and their absence at other stratigraphic levels, indicates contemporaneous deposition during an unusual event. The spherules differ substantially from other impact-generated melt ejecta (glassy microtektites and microcrystalline microkrystites) and, currently, we are not confident of their origin nor of their provenance. The presence of possible fossils within some spherules suggests that at least some are probably Mn seafloor precipitates, though why they are restricted to one stratigraphic horizon is currently unknown. Additional studies are underway to isolate the clastic quartz component from the hosting sediment in order to check for the presence of shock features. Finally, a comparison with the clast composition either side of the spherule horizon will be performed in order to determine if the mineral composition, density and angularity within the spherules is similar to that of adjacent sediment.

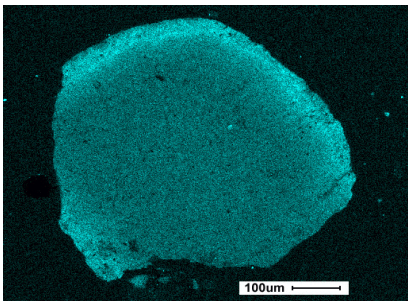

Figure 3 Ca X-Ray map showing calcic rim on unbroken surfaces

References.

Stewart, S.A. and Allen, P.J. 2002. A 20-km diameter multi-ringed impact structure in the North Sea. Nature, v.418, p.520-523.