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Provenance of Late Cretaceous to Paleocene submarine fan sandstones in the Norwegian Sea: Integration of heavy mineral, mineral chemical and zircon age data

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Abstract

This paper describes a strategy for effective discrimination and provenance evaluation of sandstones transported by different sediment dispersal systems using an integrated programme of heavy mineral analysis, mineral chemistry and zircon age dating. Sandstones derived from different source regions are initially discriminated using provenance–sensitive heavy mineral parameters (ratios of abundances of stable, hydraulically equivalent minerals). Differences between the heavy mineral populations are reinforced by single-grain mineral chemical analysis, which also provides further information on the nature of the source terrains. Zircon age dating of representative samples places further constraints on the location of the source areas, by identifying the main crust-forming events. In addition, the validity of the mineralogical discrimination can be tested by the zircon age data.

The value of this integrated approach is illustrated by a case study of deep marine Late Cretaceous–Paleocene sandstones in the Norwegian Sea. Potential sources of coarse clastic sediment lie both to the east, in mid-Norway, and the west, in East Greenland. Three main sand types (MN1, MN2 and MN3) have been identified, each of which has a unique combination of heavy mineral ratios (rutile/zircon, monazite/zircon, chrome spinel/zircon and apatite/tourmaline) and mineral chemistry (garnet and tourmaline). Sand type MN1 has a simple zircon age spectrum, with a large Early–Middle Proterozoic group and a small Early Paleozoic group, indicating derivation from northern mid-Norway. Sand type MN2 has a complex age structure including Archaean and early Proterozoic zircons. It can be divided into two subtypes, MN2a and MN2b, and can be ascribed to a source in East Greenland. Sand type MN3 has a simple age structure dominated by Middle Proterozoic zircons, and it was sourced from southern mid-Norway. Since reservoir presence is a major area of uncertainty in the deep water Norwegian Sea, the use of heavy mineral, mineral chemical and zircon age data to discriminate sandstones of eastern and western origin is crucial to hydrocarbon exploration of the area.

Keywords: Provenance; Heavy minerals; Zircon; Cretaceous; Paleocene; Norwegian Sea

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