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Holocene sea-level change: geological records from the Skagen Odde spit system, Denmark

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Skagen Odde (northern Jutland, Denmark) is one of the largest spit systems in Europe. The spit, which now has a length of more than 30 km, has developed over the past 7000 years and spit growth towards the northeast is linked to a relatively continuous supply of marine sand and gravel transported north-eastward by longshore currents (Clemmensen et al. 2001; Nielsen & Johannessen 2009). Short-term spit development has been controlled by near-shore marine processes in a high-energy, wave-dominated environment and by aeolian reworking of beach and spit deposits and related dune formation (Clemmensen et al. 2001; Nielsen & Johannessen 2009). Long-term spit evolution has also been influenced by considerable variation in relative sea level.

Reliable age models are required to unravel the details of the relationship between the long-term evolution of the Skagen Odde spit system and relative sea-level variation. Early models relied on radiocarbon-dating of swale peats (Clemmensen et al. 2001). Clemmensen & Murray (2010) used optically stimulated luminescence (OSL) dating to test the reliability of this method to the spit system in question and made a first comparison between OSL dating and radiocarbon-dating of the spit deposits. Their results indicated that the OSL age of the three test sites were in good agreement with previous chronology based on radiocarbon dating.

Along the western side of Skagen Odde there is an almost continuous c. 15 km long section of spit deposits; in this study we use OSL dating of beach and backshore aeolian deposits to obtain supplementary age control on Skagen Odde spit development between 5000 and 2000 years ago. We define a new sedimentary proxy (foreshore-backshore boundary) for sea level and measure its elevation at 36 sites with the aim to look for variations in past sea level. The new elevation data indicate that the elevation of the foreshore-backshore boundary drops from about 11 m in the south (5000 years ago) to about 2.5 m towards the north (2000 years ago), and finally to about 0.8 m at the modern beach. The data points can be fitted by a curve being progressively steeper back in time. Data points between 5000 and 4000 years ago have values above the curve, while data points thereafter have values close to the curve. The data suggest that the isostatic rebound rate decreased between 5000 and 2000 years ago from about 3.5 mm/yr to about 1 mm/yr. Eustatic sea level was apparently high prior to 4000 years ago, dropped dramatically just after 4000 years ago and stayed close to modern values during the past 3500 years. But more work is needed to determine the age, magnitude and regional variation of the inferred sea-level change around 4000 years ago, and to distinguish between absolute and relative sea-level change.

References

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