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The Karakum and Kyzylkum sand seas dynamics; mapping and palaeoclimatic interpretations

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Sand seas are large basins in deserts that are mantled by wind-swept sand and that exhibit varying degrees of vegetation cover. Wilson (1973) was the first to globally map and classify sand seas. Beyond Wilson's maps, however, little research has been published regarding the Karakum and Kyzylkum sand seas of Central Asia. Wilson's maps delineate active ergs from inactive ergs based solely on precipitation. His assumption of annual average rainfall as a factor determining mobility vs. stability of sand seas is too simplistic and does not take into consideration other factors such as biogenic soil crusts and wind power, both of which are known to have major effects on the dynamics of sand dunes. Literature related to mapping and classifying the Central Asian ergs by remote sensing or sand sea classification state (stable/active) is lacking. Moreover, the palaeoclimatic significance of dunes in Central Asia is difficult to assess, as there has been few studies of dune stratigraphy and numerical ages are lacking. Optically stimulated luminescence (OSL) is a firm optical dating method that is used to determine the elapsed time since quartz grains were last exposed to sunlight, thus, their burial. Yet, absolute ages indicating mobilization and stabilization of these sands, are still inadequately known and are here under discussion.

The broad concern of this research was to determine the dynamics of the Central Asian sand seas and study the palaeoclimatic changes that brought to their stabilization. As there are no reliable maps or aeolian discussion of these sands, establishment of a digital data base was initially conducted, focusing on identifying and mapping these sand seas. The vast area and inaccessibility make traditional mapping methods virtually impossible. A variety of space-borne imagery both optical and radar, with varying spectral and spatial resolutions was used. These images provided the basis for mapping sand distribution, dune forms, and vegetation cover. GIS analysis was performed in parallel with field work to obtain validation and verification.

The remote sensing and GIS results show that these ergs are mostly stabilized, with the estimated sand mantled area for the Karakum desert ∼260,000 km2, and for the Kyzylkum it is ∼195,500 km2. Meteorological analysis of wind and precipitation data indicate a low wind power environment (DP< 200) and sufficient rainfall (>100 mm) to support vegetation.

Thus, these sands are indicative of past periods during which the climate in this region was different than today, enabling aeolian sand activity. Optically stimulated luminescence ages derived from the upper meter of the interdune of 14 exposed sections from both ergs, indicate sand stabilization during the mid-Holocene. This stabilization is understood to reflect a transition to a warmer, wetter, and less windy climate that generally persisted until today. The OSL ages, coupled with a compilation of regional palaeoclimatic data, corroborate and reinforce the previously proposed Mid-Holocene Liavliakan phase, known to reflect a warmer, wetter, and less windy climate that persists until today and resulted in dune stabilization around the Mid-Holocene.