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The Dead Sea fault: structure, palaeoclimate and influence on mankind

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The Dead Sea fault (DSF) is the most impressive tectonic feature in the Middle East (Fig. 1). It is a plate boundary, which transfers sea floor spreading in the Red Sea to the Taurus collision zone in Turkey. The DSF has influenced many aspects of this region, including seismicity, geomorphic development and local climate fluctuations. It may have even affected the course of early hominid dispersal out of Africa.

The region has a remarkable paleoseismic record going back to about 70 ka years. Several earthquakes, such as the one that occurred in the Dead Sea region on 31 BC, may have even influenced the course of history of this region. The confusion and fear inflicted by the earthquake paved the way for the expansion of Herod's kingdom. The immense effect of seismic activity is evident in numerous archaeological and historical sites along the DSF.

Numerous geophysical and geological studies of the Dead Sea fault provide insight into its structure and evolution. Crustal structure studies have shown that the crust at the fault zone is slightly thinner than that of the regions west and east of it. These differences in crustal structure may have controlled the evolution of physiography in the region. Since the Late Miocene the margins of the rift valley were uplifted in several stages and the rift floor subsided, capturing the local drainage systems and creating the present-day physiography. A series of sub-basins evolved along the DSF, some of them bellow mean sea level. The lowest place along the DSF (and on Earth) is the Dead Sea basin. Acceleration in the vertical motion across the DSF occurred in two main phases: the first in the Miocene – Pliocene transition and the second in the Plio-Pleistocene transition, shortly before the first dispersals of hominids from Africa (Fig. 2).

Concurrently, with the initiation of glaciations in the Northern Hemisphere ~2.6 Ma ago the earth witnessed frequent and large-scale oscillations between glacial and interglacial conditions. This climatic change continued with two further steps at ~1.7 Ma and at ~1.0 Ma. Warm and humid climate occurred over the Levant and northeast Africa during interglacial periods coinciding with maximal insolation at 65°N in the northern

Figure 1 - Sites along the Dead Sea fault mentioned in the text on the Digital Terrain Model (DTM).

hemisphere, while cold and dry climate occurred during glacial maximum and during periods equivalent with Heinrich events. In between these extremes, dry and warm interglacial periods of broad extent, as well as cool and more humid glacial intervals of local to more regional extent, existed in the region. Climatic fluctuations in the Levant and northeast Africa are directly attributed to the amount of overlap between two major climatic systems: the high-latitude NE Atlantic/Mediterranean and the low-latitude African/west Asian monsoon.

Under these climatic conditions the morphotectonic sub-basins along the DSF evolved into unique ecological niches for flora and fauna, some containing water-bodies. During warm and humid interglacial, maximal overlap between the Atlantic/Mediterranean and monsoon systems resulted in expansion of the vegetation cover in the present-day dry and barren areas of the Sahara and Arabian deserts. Some cool and humid intervals occur during glacial stages coinciding with enhanced rainfall in the Levant and milder and more humid conditions in NE Africa with overall lower air-temperature compared to the humid interglacial intervals. Humid intervals occurring periodically during glacial stages seem to be more suitable for hominid dispersal out of Africa. During these periods the climatic conditions in East Africa and at the Levantine corridor are more favorable.

Along the DSF, the presence of water-bodies offered favorable and more suitable environments for settlements of hominids in prehistoric as well as historic times, as evident in sites, such as ‘Ubeidiya, Gesher Benot Ya‘aqov, Ma‘ayan Baruch and Nahal Zihor (Fig. 1). The unique ecological niches provided food (fauna and flora), freshwater and availability of raw materials for tool making. In several sectors of the DSF sedimentological sequences comprise extremely long records of human presence. Despite regional climatic changes and other factors that influenced the size and nature of the water-bodies, the hominid occupations show repetitive visits and exploitation of particular niches along the DSF.

Partial isolation of basins such as the Gulf of Aqaba and the Dead Sea from the global oceanic system contributes significantly for data recording in the sediments and its preservation. Surrounded by semi-arid to arid landmasses these sub-basins accumulated thick sedimentary sequences, which can be easily dated by correlation with the global marine record through the common marine oxygen isotope chronostratigraphy. This differs considerably from the records on land that are in general more fragmentary and difficult to put in an accurate time frame.

Remains of the most ancient hominids outside Africa are found along the DSF, which actually formed a preferable corridor through which hominids set off out of Africa. The geological evolution of the DSF, its changing climate and the active tectonic processes occurring along its length, thus, may have affected the course of human history.

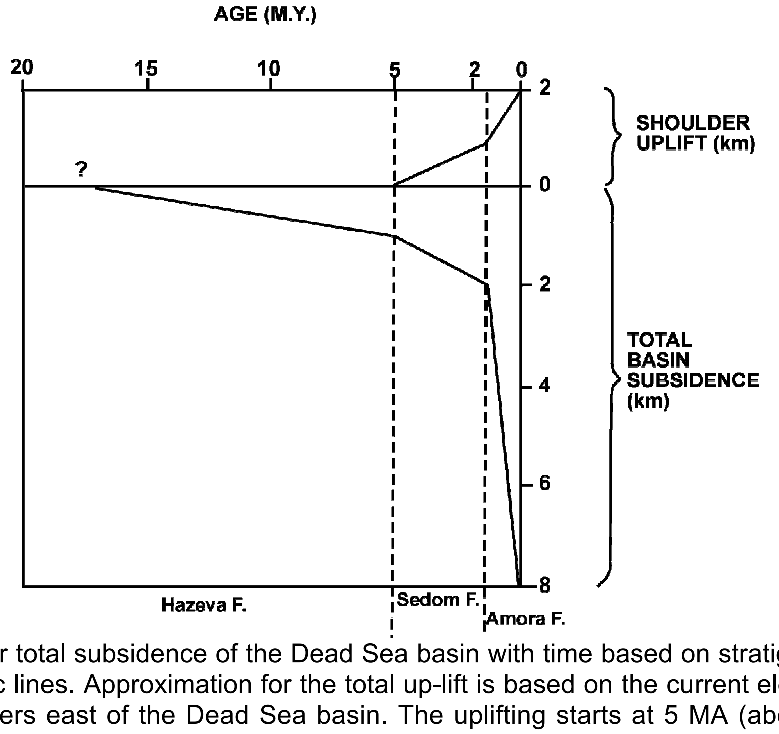

Figure 2 - Estimates for total subsidence of the Dead Sea basin with time based on stratigraphic interpretation of seismic lines. Approximation for the total up-lift is based on the current elevation of Late Cretaceous layers east of the Dead Sea basin. The uplifting starts at 5 MA (about 70-50% of the total uplifting along the rift), and the second phase (Early Pleistocene) of 50-30% of the total uplift.