



Evolution of the Isthmus of Panama: biological, paleoceanographic, and paleoclimatological implications

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The rise of the Isthmus of Panama has been the product of small-scale geological processes that, however, have had worldwide repercussions. Four major events have been linked to the rise of the Isthmus including 1) the onset of the Thermohaline circulation (TCH), 2) the onset of Northern Hemisphere Glaciation, 3) the birth of the Caribbean Sea, and 4) the Great American Biotic Interchange (GABI). The available evidence indicates that there is a strong link between the closure of Central American Seaway (CAS) and the onset of Atlantic Meridional Overturning Circulation (a precursor of THC), but at 10 Ma rather than at 3.5 Ma as it was assumed before. There are not evidences of a connection between the full emergence of the Isthmus at 3.5 Ma and the onset of the NHG. There are strong evidences that the full emergence of the Isthmus at 3.5 Ma changed the oceanography of the Caribbean Sea to its modern conditions, although the role of additional variables into Pleistocene Caribbean Sea conditions still need to be evaluated, including the changes in the climate of the Pleistocene and the cessation of the freshwater flow of several South American rivers into the Caribbean. GABI is more complex than often assumed and it seems that variables other than a continuous terrestrial Isthmus have controlled the direction, timing and speed of migrations. The building of Panamanian landscape can be summarized in four phases, 1) a late Eocene large island in central Panama and the Azuero Peninsula, 2) an early Miocene large scale generation of terrestrial landscapes in Central America that connected central Panama with North America, 3) a full closure of CAS at 10 Ma, interrupting the exchange of deep waters between Caribbean and Pacific, and generating most of the landscape across the Isthmus. Exchange of shallow waters continued until 3.5 Ma, albeit intermittently. 4) A continuous terrestrial landscape across the Isthmus over the past 3.5 Ma.