

Tectonic and paleogeographic setting for the development of grassland environments and evolution of extensive hypsodonty in herbivores in Early Oligocene times in central Chile (32°-36°S)

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A dominant feature of the Cenozoic evolution of the Central Andes in Chile is the development of an extensional basin in Late Eocene to Late Oligocene-Early Miocene times. This basin developed on the eastern side of a NNE-SSW oriented topographic high or "Incaic Range" formed between at least ~20-34°S. This relief resulted from the late Middle Eocene (~40 Ma) tectonic inversion of the Late Cretaceous-Early Paleogene arc/intraarc domain. The basin reached northward to at least 29°S, and to the south extended to ~39°S in Chile and up to ~44°S in Argentina. This basin and related sub-basins, thus constituted a >1000 km tectonic and paleogeographic feature of the Southern Central Andes. Basin subsidence has been attributed to weak coupling between the subducting and overriding plates during a period of slow convergence and/or steep slab subduction after a pulse of rapid convergence that apparently triggered the Incaic inversion. In the western Principal Cordillera, between 32° and 36°S, extension occurred along three major ~N-S oriented major fault-systems, from W to E: (1) the east-dipping Infiernillo-Cerro Renca-Portezuelo Chada (ICRPC) and (2) Pocuro-San Ramón (PSR), and (3) the west-dipping El Diablo-Las Leñas-El Fierro (EDLLEF). Two main depocenters forming between these faults were infilled by the >3000 m thick, terrestrial, dominantly volcanic and volcanoclastic Abanico Fm. Locally thick lacustrine successions, intercalated with lavas and coarse volcanoclastic deposits, reflect the importance of lakes and volcanism within the basin. We have discovered richly-fossiliferous volcanoclastic horizons spanning much of the thickness of the Abanico Fm. in >13 areas across this region. More than 1,600 specimens of rodents, marsupials, armadillos, sloths, a great diversity of notoungulates (extinct hoofed mammalian herbivores), teleost fishes, bird bones, a turtle and a nearly complete monkey skull have been recovered. Dentitions of most of the fossil mammals from Early Oligocene deposits of the Termas del Flaco region in the Tinguiririca valley (Tinguirirican South American Land Mammal "Age") are extremely high-crowned (hypsodont) compared with their low-crowned immediate forebears. The appearance of hypsodonty, a condition making teeth more resistant to wear by abrasive food, together with statistical analyses of the number of species within different body size categories and their ecological attributes (cenogram, macroniche, and discriminant function analyses) suggest adaptation of these animals to an open, dry grassland/patchy woodland environment that developed shortly after extensional basin development began; this shift from earlier more forested conditions, presumably reflects a cooler, drier climate.

Reduced mid-ocean spreading rates and associated eustatic sea-levels are potentially tied to the development of colder terrestrial climates such as occurred during the Oligocene. The former may also be linked to low convergence rates on the margin of western South America and extensional basin development in the region at this time. These geodynamic and tectonic events, climatic cooling, development of grassland environments, and the appearance of hypsodont dominated herbivore faunas are thus plausibly related.

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