

PREFACE

Late Cenozoic Evolution of the Central Anatolia Plateau

Introduction: Located within one of the world's most seismically active areas, the Central Anatolian Plateau (CAP) and its neighboring high-elevation regions constitute a relatively small orogenic plateau. Despite its modest average elevations between 1.2 and 1.5 km and low overall exhumation, the CAP is a first-order morphotectonic feature that has fundamentally impacted the geologic, geomorphic, and climatic evolution of the Eastern Mediterranean. Central Anatolia is the only orogenic plateau in the world today that appears to be in a nascent stage when compared to its much more extensive counterparts in the India–Eurasia collision zone, the noncollisional Andean Plateau, or the Colorado Plateau. While much attention has been focused on the Aegean extensional zone to the west and the Eastern Anatolian plateau to east with respect to deformation mechanisms and the spatiotemporal characteristics of uplift, the morphological, environmental, and geodynamic evolution of Central Anatolia have remained largely enigmatic. However, due to its limited area and modest elevation, the CAP lends itself to unraveling these issues through a multidisciplinary approach.

The tectonically active boundaries of the CAP delineate the Anatolian plate, which has been extruding toward the west with respect to Eurasia since the Miocene as the result of extension in the Aegean and the Arabia–Eurasia collision. The northern and southern flanks of the plateau are bounded by the Pontide and Tauride mountains, which attain elevations in excess of 2000 m, posing significant barriers to modern precipitation. In both mountain ranges, the interplay between tectonic plateau uplift and associated fluvial incision has created deeply incised gorges with strath and fill terraces that constitute valuable proxies for the recent uplift history of the plateau margins. The southern margin furthermore contains extensive uplifted marine sediments, providing a longer-term perspective on surface uplift. While the northern plateau margin is part of an active, bivergent orogenic wedge partly related to the broad restraining bend in the NAF, the southern plateau margin does not present obvious active structures able to justify the post-Miocene monoclinical tilting displayed by Miocene sediments.

Between these 2 margins, the plateau interior comprises tectonic units assembled during Mesozoic to Tertiary orogenies. Related rocks are unconformably covered by extensive, thick successions of Miocene to Quaternary fluvio-lacustrine sediments and pyroclastic deposits at present separated by basement highs. The >1500 km² Tuz Gölü (Salt Lake) in the center of the plateau is only a remnant of these sedimentary systems. The extent of such lakes as well as the amount of material stored within their basins underscores the pivotal role of internal drainage and sediment storage in the development of the plateau and of the substantial tectonic movements occurring in the plateau during uplift. Lake sediments include a wide range of deposits and form well-preserved archives of plateau development that record tectonic deformation within the plateau and possibly tectonically driven climate change and fluvial adjustments, while the structures exposed at the basin margins and the plateau flanks record the deformation kinematics during plateau evolution.

Background: With average elevations of several kilometers, low internal relief, high and deeply incised flanks, and pronounced climatic gradients across their margins, orogenic plateaus are first-order morphotectonic features that are an integral part of the largest mountain ranges on Earth. Despite being located in different geodynamic environments and climate zones, orogenic plateaus display several unifying characteristics, such as anomalous lithospheric thickness, magmatic activity, high heat flow, and complex interactions between tectonic and climatic processes. In fact, all Cenozoic plateaus profoundly impact climate and precipitation patterns due to the efficient orographic barriers imposed by their steep flanks. Higher precipitation and runoff, high-density stream networks, and high erosional capacity characterize the windward slopes of these regions. Conversely, arid conditions with internal drainage and rivers with low erosional capacity define plateau interiors, thus creating strongly contrasting geologic and climatic conditions.

Previous plateau studies have alluded to possible linkages among seemingly disparate processes in the evolution of orogenic plateaus and climate. These include the uplift of Tibet and the onset of the Indian Summer Monsoon, a pronounced shift in precipitation patterns associated with the South American Monsoon, the evolution of fluvial megafans in the Bolivia foreland, and the development of a marked rain shadow in the Great Basin region of the western United States. Orogenic plateaus are thus among the best geological settings to investigate the synergistic interaction between deep-seated and surface processes to shape Earth's surface.

Structural models interpret the evolution of plateaus in terms of consecutive, yet related stages in crustal shortening and thickening, while thermo-mechanical models address magmatic crustal addition, lower crustal flow, or delamination. One popular model of plateau uplift involves removal of mantle lithosphere by delamination, followed by rather rapid, isostatically driven surface uplift and ensuing high-elevation extensional processes. Alternatively, the onset of uplift in an area previously experiencing subsidence could be related to changes in subduction mechanics. Yet other models link the tectonic activity of mountain ranges in nascent plateau areas and the formation of low-relief environments in the orogen interior to climatic conditions and rock erodibility. In this view, internally drained plateau areas develop as a consequence of the successive build-up of orographic barriers and intervening basins that become subsequently infilled with sediment due to hydrologic isolation.

The defeat of the drainage network is thus marked by a changeover from externally to internally drained basins that ultimately become overfilled and coalesce, leading to smooth basin surfaces and a reduction in relief in the plateau interior. Ultimately, the conspiring effects of shortening, uplift, and sediment storage may help the lateral growth of plateaus as foreland areas are incorporated into the orogen due to an increase in potential energy in the plateau areas, which drives uplift and deformation away from the plateau margins.

The Central Anatolia Plateau (CAP), the TOPOEUROPE initiative, and the Vertical Anatolia Movements Project (VAMP): Building on the original ideas of Şengör and others, a small group of geoscientists from different European universities under the auspices of the TOPOEUROPE initiative identified the CAP as an ideal locality to study the early stages of orogenic plateau development. Compared with its more famous counterparts, the CAP has the main advantage of being very compact and accessible, thereby making it possible to investigate the most relevant aspects of its evolution in an areally limited environment. Different from other continental orogenic plateaus, this includes also the marine domains surrounding the plateau, which was subjected to marine depositional environments prior to and during the early stages of uplift. All of these activities were made possible by the very large body of data acquired by Turkish geologists in previous decades.

On this basis, VAMP was developed and ultimately approved by the TOPOEUROPE Initiative of the European Science Foundation in 2008. Under the VAMP umbrella, senior researchers, postdoctoral scholars, and students from 9 universities in Turkey, Germany, the Netherlands, Italy, Slovakia, and Canada worked in different parts of the CAP, holding workshops and meetings.

VAMP focused on many facets of orogenic plateaus, addressing a wide range of temporal and spatial scales of plateau formation in Central Anatolia, involving studies from basin-scale sedimentology, paleontology and tectonics, paleo-altimetry and stable isotope analysis, structural and geomorphic analysis, analysis of seismic reflection lines, magnetostratigraphy, and 2D and 3D numerical modeling of plateau formation. The chosen target areas included the interior of the plateau and its northern and southern margins, as well as the adjacent offshore domains.

The VAMP Special Volume: This special volume brings together 9 papers presenting some of the results obtained by VAMP researchers during the last 4 years. These contributions cover most of the domains relevant for the CAP and provide a good impression of the variety and quality of the work done. Two manuscripts (Özsayın et al. and Fernández-Blanco et al.) discuss the tectonic evolution of the Tuz Gölü Basin using several complementary methods. Aydar et al. used erosion/incision patterns of radiometrically well-constrained Neogene-Quaternary ignimbrites of the Cappadocian Volcanic Province to calculate river incision rates and to interpret landscape evolution. The Çankırı Basin, situated in the northern part of Central Anatolia, was also studied by 2 different groups (Mazzini et al. and Lucifora et al.) with 2 distinct objectives focused on tectonics and chronology. Lüdecke et al. presented a comprehensive set of long-term oxygen ($\delta^{18}\text{O}$) and carbon ($\delta^{13}\text{C}$) stable isotope records from 5 lacustrine sequences distributed over the CAP. Three manuscripts examining the southern basins of the Anatolian Plateau are also presented in this special volume. Two of them (Faranda et al. and Ilgar et al.) deal with paleoenvironmental and tectonic/eustatic forcing of the Adana Basin and Cipollari et al. is dedicated to the paleogeography of the Mut–Ermenek Basin.

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