T 23

TECTONICS OF CENTRAL AND WESTERN IRAN

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The fault-plane solutions of the last decade earthquakes together with all previous focal mechanism studies are used to obtain a better understanding of the tectonics of central and western Iran.

Earthquake records from the Iranian Long Period Array (ILPA) and other stations are used to study the seismotectonics of the ILPA area and Tehran region. The epicentral locations show that the activity is concentrated in several groups. Composite fault-plane solutions are made for each group and travel time residuals and migration of foci are studied. The results obtained give a new picture about the seismotectonics of the ILPA area and Tehran region.

T 24

SEISMOLOGICAL CONSTRAINTS ON THE COMPENSATION OF IRANIAN PLATEAUS

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Seismological observations in Iran have placed new constraints on models for continental plateaus behind collision zones. Pn velocities range between 8.0 and 8.2 km/sec over the Iranian plateau, corresponding to normal mantle values. The uppermost mantle shear Sn phase propagates efficiently over the plateau except along its northern edge, where Sn is strongly attenuated. A variety of models have been invoked to account for the remarkable elevation of the Tibetan or Iranian plateaus. They require the presence of unusually low density material beneath these areas, presumably a shallow asthenosphere (Toksoz and Bird), or highly thickened crust, or both. Thickened crust could arise from compression (Dewey and Burke) or by underthrusting of Asia by a second crustal layer (Powell and Conaghan). Both of these could be accompanied by 'continental escape' as described by Molnar and Tapponier. Powell and Conaghan have pointed out that the surface geology of Tibet is inconsistent with the 50% shortening required by the crustal thickening model. Our observations of normal Pn velocities and efficient uppermost mantle Sn propagation across a major portion of the Iranian plateau argue against a replacement of the lithospheric mantle by hot asthenosphere. The existence of normal mantle beneath the plateau is consistent with lithospheric underthrusting. The suggestion is that models requiring compensation of Iranian plateaus by anomalous upper mantle are no longer viable.

T 25

THE EAST ANATOLIAN TRANSFORM FAULT: ITS AGE, OFFSET AND SIGNIFICANCE IN THE NEOTECTONICS OF THE EASTERN MEDITERRANEAN

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The seismically active and morphologically distinct East Anatolian transform fault extends for 400 km from Karliova in the east to Kahramanmaraş in the west and marks a southeastern left-lateral strike-slip boundary between the Anatolian plate and the Arabian plate. It offsets a Middle Miocene marker horizon near Gölbasi for 18 km and an unconformity between Miocene and crystalline rocks for 22 km near Göynük. Fault-controlled basins along the transform contain Pliocene lignite, bracketing the initiation of the fault between the medial Miocene and the Pliocene. The fault ends in two continental triple junctions where incompatibility has led to the formation of complex intracontinental basins in Karliova and Adana/Cilicia. Northwest trending left-lateral strike-slip faults splay from the main trunk (e.g., the Elbistan Fault) and become part of the internal Anatolian extensional regime. Along the fault there is one major "locking" segment near Bingol, a site of frequent earthquakes (e.g., May 22, 1971). The temporal correlation between the East and North Anatolian faults and their geometric similarity (in mirror-image) supports the notion that as Anatolia is being squeezed away from the East Anatolian compressional zone it is extending north-south along conjugate strike-slip faults that splay off from the two main transforms. Mapping west of Lake Hazar shows that subparallel strike-slip and normal faults result in a 6 km wide asymmetric transform valley with a stepped southern wall. Strike-slip faulting dominates but parallel normal faulting occurs on the higher southern wall as fault blocks descend into the eroded transform valley.

T 26

NEOTECTONICS OF EASTERN TURKEY: NEW EVIDENCE FOR CRUSTAL SHORTENING AND THICKENING IN A COLLISION ZONE

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Detailed field mapping, interpretation of air photos and LANDSAT images, and limited seismic reflection profiling reveals the following dominant structural and tectonic styles in the eastern Turkish part of the Turkish-Iranian high plateau: 1) NE-SW striking, left-lateral strike-slip faults (e.g. Malazgirt Fault); 2) WNW-ESE striking, right lateral strike-slip faults (e.g. Tutak Fault); 3) roughly E-W striking, generally high-angle thrust faults with both northerly and southerly vergence (e.g. the bounding thrusts of the Muş Basin); 4) roughly N-S striking fissures, many of which are sites of recent volcanism (e.g. Mt. Nemrud); 5) fold packets with axes trending roughly E-W affecting the Pliocene (and locally younger) sediments (e.g. near Ahlat). All these structures appear to be active as shown by seismicity and geomorphology. Most major depressions on the plateau are compressional in origin with bounding thrust faults. One major characteristic of all these structures is that they are discontinuous and change from one type to another along strike. They result in N-S shortening of the plateau accompanied by crustal thickening and limited E-W extension. The shortening is widely distributed yet inhomogeneous. The geological history of the area indicates that the present regime was established by mid to late Miocene times (~10 m.y. ago). The temporal correlation with the Arabia/Anatolia collision and the coincidence of the zone of crustal thickening with Plio-Quaternary volcanism supports the notion that eastern Turkey is an embryonic Tibetan-type high plateau.

T 27

A MAJOR NORTHWEST TRENDING PRECAMBRIAN STRIKE SLIP FAULT IN PENNSYLVANIA

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The Tyrone-Mt.Union lineament (TMUL) extends from the NW corner of PA to near South Mountain in SE PA. In plate tectonic scenarios seeking to explain the underlying cause of the South Mountain salient (a major bend in the Appalachians) the TMUL has been considered to be the location of either a failed third arm (Rankin,1976) or a transform fault (Thomas, 1977). The rifting in both models is thought to be pre-Taconic (or Precambrian), hence the more recent sedimentary rock which blankets western PA shows no evidence of it. Gravity and magnetic maps have been studied to see if the geophysical data permit offsets of the size and sense required for the transform fault model. At first glance the NY-AL aeromagnetic lineament of King and Zietz (1978) may seem to preclude such major offsets across it. Close inspection of the aeromagnetic map of PA, however, reveals that the lineament is poorly defined in SW PA. Moreover, if the map is cut along the TMUL and the two pieces are moved so as to "restore" 60 km of right lateral motion, the magnetic lineaments which result are more regular and extensive than those which existed before. Restoring this offset along the TMUL also results in the alignment of the Scranton Gravity High with a gravity high of similar trend in SW PA, and the alignment of the Kane Gravity High of north central PA with a gravity high in Ohio. The fact that both NE trending gravity features and NNE trending magnetic features are made more continuous by restoring them to "pre-transform" positions supports the existence of the proposed transform fault.

T 28

CONTINENTAL MARGIN ARC TECTONICS DURING THE HERCYNIAN OROGENY, EASTERN UNITED STATES

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Present day convergent margin tectonics are defined by an arcuate distribution of volcanic/plutonic rocks. The curvature of these arcs has been used to estimate convergence rates and angles of subduction. Recognition of such arcuate distribution of igneous rocks belonging to a single orogeny in the geologic past provides important restrictions on paleotectonics.
Along the eastern margin of the United States (Maryland to Georgia), the Hercynian (330-260 m.y.) plutons define an arcuate pattern. Although extensive erosion has removed all evidence of volcanic rocks, the plutons define a band with a radius of curvature with an RC angle of 5.6° (terminology of Tovish and Schubert, Geophy. Res. Letters, v.5, p.329-332, 1978), and by analogy with recent arcs, a spreading rate of less than 5cm/yr. Oxygen isotopic compositions and selected trace elements in these plutonic rocks show a regional and systematic variation within this arc. Along the strike of the arc, concentrations and isotopic compositions are similar; across the strike, they vary in a systematic manner. Similarly, aeromagnetic and gravity data show a pattern consistent with the arcuate distribution of plutons.
Although the geochemical and geophysical evidence is complicated by a late Hercynian continent-continent collision, we believe that the integrity of the arcuate pattern suggests that only minor readjustment of the arc has taken place. Our model suggests that the allocthonous nature of parts of the central Appalachians (Blue Ridge, Inner Piedmont) as documented by recent COCORP data (Cook et. al., Geology, v.7, p.563-567, 1979) may not extend east of the King's Mountain Belt.

T 29

ISOSTATIC EFFECTS OF A MOVING THRUST TERRAIN

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Simple elastic models of the deflection of continental lithosphere due to a cratonward moving allochthonous mass show that, 1) deflection is significant and contributes to the formation of foreland basins and that, 2) the slope of the basement beneath this mass is increased, though not greatly. For instance, the deflection of the lithophere due to the eastward progression of the Idaho-Wyoming thrust terrain may be modeled as a wedge-shaped mass 50 km broad across strike and 5 km thick at the back edge composed of rocks w/ density 2.3 gm/cc moving over continental lithosphere of flexural rigidity (D) of 10^{31} dyne-cm. Basement dip will increase 0.3° and a basin 800 m deep along its axis and 270 km broad will from in front of the thrust mass. Also, the basin axis will shift eastward as the thrust mass progresses in that direction, consistent with the gross sedimentation pattern in western WY and eastern ID during the Mesozoic and early Tertiary. The inner zero crossing of the basin profile corresponds to a possible western edge of an eastward progressing regional high. This feature could show up in the sedimentary record as erosion, non-deposition or reduced sedimentation depending upon global sea level. The distance of this point from the basin axis is a measure of flexural rigidity. Sediment fill increases both the wavelength and amplitude of the distrubance. Viscoelastic models show that

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Cover. A topographic map of Venus. The Pioneer Venus radar altimeter has obtained data for more than 80% of the Venusian surface, and these data have been used to generate maps from which the geomorphology and geologic history of the planet can be inferred. The map shown was generated from data taken at l/2-km intervals.

Three highland areas are recognizable from the topographic data collected to date. The northern region, Ishtar Terra, is the size of Australia. Its western part consists of an extensive high plateau, Lakshmi Planum, which is higher than the Tibetan plateau on earth. Like Tibet, it is rimmed by high mountains, Akna and Freyja Montes to the west and north and Maxwell Montes to the east. The highest point in Maxwell Montes is as high as Everest; it may be a large volcano with a caldera 100 km in diameter offset from the summit. The asymmetric location of the caldera suggests that the northern and eastern parts of the feature have been partially disrupted by faulting.

Aphrodite Terra, an equatorial highland area half the size of Africa, appears to be less topographically distinct than Ishtar. Its degraded appearance may indicate it is older. Three rift valleys with flanking ridges lie south and east of Aphrodite Terra, and mark a tectonically disturbed region. A similarly disrupted zone lies east of Ishtar Terra.

The third highland region, named Beta Regio, contains two great volcanic shields that are thought to be basaltic in composition. This volcanic zone is longer than the Hawaii-Midway region. From ground-based observations, a high region may occur in the area where Pioneer Venus has not yet obtained altimetry data; this gap will be filled in during the spring of 1980.

The most extensive terrain unit on Venus is a rolling upland plains unit that is prominently displayed in the central part of the map. This geological unit includes about 70% of the mapped surface. It contains many near-circular features that probably are impact craters; however, volcanic centers may also occur in this region.

Lowland areas comprise about 20% of the surface; they are located in the northeastern part of the map and form a large x-shaped area centered at 30°N, 30°E. The lowlands are not cratered and may be covered by relatively young basalt flows like the lowlands of the earth, moon, and Mars. (Photo courtesy of H. Masursky and E. Eliason, U.S. Geological Survey, and G. Pettengill and P. Ford, M.I.T. An expanded article will appear in an upcoming issue of *EOS*.)