14-3 15:10 Zitter, T.A.C.

FLUID SEEPAGE ALONG THE NORTH ANATOLIAN FAULT, IN THE SEA OF MARMARA, IN RELATION WITH TECTONICS AND SEDIMENTARY ENVIRONMENTS

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Along the submerged section of the North Anatolian fault system within the Sea of Marmara, the Main Marmara Fault (MMF) is a case study on coupled fluid and deformation processes. Indeed, numerous sites of fluid venting occur in association with the active deformation at this major transcurrent plate boundary. Recent surveys combining visual observations, acoustic sounding, sampling, and long term instrument deployments permitted us to relate fluid outflow with geomorphologic and tectonic features.

Since the Izmit earthquake in 1999, a wide range of marine datasets were acquired in the Sea of Marmara. Multibeam bathymetric data image seafloor traces of active faults, as well as significant mass wasting processes affecting the steep slopes of the Sea of Marmara. Seafloor deformation and fluid emissions were observed with ROV during the Marmarscarps cruise (2005), with manned submersible during the Marnaut cruise (2007), and recently with AUV during Marmesonet cruise (2009). Various structural contexts were surveyed: strike-slip localized on a single linear fault (e.g. Western High), releasing and compressive jogs on the main strike-slip fault (e.g. Kumburgaz basin and Central High), fault segments with combined strike-slip and normal slip (N Cinarcik scarp), en-echelon normal fault system (S Cinarcik basin), and a basin edge with minor transpressive deformation (NW Tekirdag). Manifestations of fluid seepage are diverse and range from highly focused brackish water outflow emitted from authigenic carbonate chimneys to more extensive and diffuse fluid seepage areas. Fluids are mainly from relatively shallow basin consolidation and gases are mainly of biogenic origin, however several fluid emission sites expel fluids originating from deep within the sedimentary basin and include thermogenic gas, oil, and brines, and possibly, mantle He.

Mapping of seep distribution indicates that fluid emissions are primarily associated with deep-rooted active faults. In particular, gas emissions are found in Cinarcik Basin above a buried transtensional shear zone, which displayed aftershock activity at its eastern end after the Izmit earthquake. In most areas where it is observed, the main strike-slip fault trace presents reflectivity anomalies indicative of fluid outflows. However, secondary extensional (normal faults), compressional structures (anticline axes), and, in some occurrences, Riedel shears also influence the distribution of seepage sites. Gas emissions are observed on NE-SW trending anticlinal ridges a km or more away from where the main fault trace crosses the ridge. Some of the emission sites are not obviously correlated with active faults. In particular, gas emissions are generally present at the base of the slopes along the edges of the basins, but these do not systematically correspond to an active fault trace. Furthermore, observations also suggest that the sedimentary environment plays a role in providing pathways for fluid expulsion, mainly in the case of diffuse seepage and water outflow. Fluid emission sites are observed in close relationship with mass wasting deposits (turbidites, debris flow) or at the toe of destabilized slopes. In the NE Cinarcik basin, fluid seepage has been observed at the base of a scree slope with meter-sized boulders. Avalanche debris and coarse sandy turbidites provide high permeability conduits to drain fluid from the basin towards the active fault scarp.

14-4 15:50 Lisenbee, Alvis L.

THE DAVUTOGLAN WRENCH FAULT: INTRA-ANATOLIAN PLATE, NEOGENE DEFORMATION, ANKARA PROVINCE, TURKIYE

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Approximately 100 km west of Ankara, the northern margin of the Haymana Basin is disrupted by a 12-km wide series of ENE-trending faults, anticlines and monoclines, the largest of which is the topographically expressed, 18-km long Davutoglan wrench fault. These structures deform Miocene fluvial and lacustrine strata north of Cayirhan and the Davutoglan fault crosses beneath Davutoglan village.

Right strike-slip on the several strands of the Davutoglan fault zone is indicated by slickenlines and mesoscopic, fault-surface features, an associated train of right-echelon folds and thrust faults (in a restraining bend), in-line horsts and grabens, and overlapping faults with an associated transfer ramp. Horizontal displacement is less than one kilometer: Vertical offset across the zone is as much as 250 m, down to the north. Offset within the fault zone decreases to the east where deformation continues as an anticline whose axis is of similar trend: To the west the faults merge into a single strand and offset decreases to zero.

Individual faults are well exposed as discreet, polished surfaces in the siliceous limestone and may have a clay-smear character in the mudstone units. These faults acted as fluid conduit, are commonly strongly iron-stained, and locally contain chalcedony veins. The enclosing grey- to green mudstones are bleached to a buff or pale orange-tan color for many meters outward from the fault surfaces.

The Davutoglan fault zone represents deformation within the Anatolian Plate, about 70 km south of the bounding North Anatolian Fault (NAF). The type of deformation, timing, and right-lateral offset suggest an origin under similar regional stresses as those of the NAF. The zone lies along the eastward projection of the Late Cretaceous-Paleocene, northern margin of the Izmir-Ankara suture beneath the Miocene deposits: It may indicate local reactivation of a part of that feature.

14-5 16:10 Koral, Hayrettin

THE NORTH ANATOLIAN FAULT ZONE IN NW TURKEY: INFERENCES FROM NEOGENE STRATIGRAPHY TO EARTHQUAKE RUPTURES

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The North Anatolian Fault (NAFZ) is a major tectonic feature of the Marmara region and NW Turkey. It follows an ancient suture zone and comprises three prominent splays. These splays delimit several Neogene basins.

The Neogene basins indicate a sedimentary sequence extending from the Oligocene to Quaternary with noted interruptions in the stratigraphy. The sequence begins with a thick and gently folded limestone that overlies disconformably a pre- Oligocene magmatic/metamorphic basement. It continues with marl-mudstone-tuff intercalations which have an age of the Upper Oligocene-Lower Miocene. The sequence continues with a distinct unconformity and is overlain by lignite bearing marl and fine clastics. It is then cut by volcanics overlain by clastics of both sedimentary and volcanogenic origin. Pleistocene clastics and a thick Holocene alluvium overlie the older units with an angular unconformity.

The sedimentary sequence in NW Turkey indicates a large inland basin modified by tectonic events as evidenced by differing depositional conditions and noted unconformities. The orderly map pattern of Neogene units suggests temporal and spatial modification of Neogene faults possibly dissimilar to the present.

The 1999 earthquakes of the Marmara region caused a surface rupture reaching to a length of over 150km. The rupture included simple as well as complex rupture geometries and slip modes. It extended largely through Quaternary deposits. This rupture pattern is considered to be representing the modern NAFZ with a rather simple through-going geometry. However, details of the rupture appear to bear many influences of the Neogene faults and Neogene fault geometry.

14-6 16:30 Esat, Korhan

NEOTECTONICS OF NORTH CENTRAL ANATOLIA: A STRIKE-SLIP INDUCED COMPRESSIONAL REGIME

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North Central Anatolia is mainly dominated by strike-slip tectonics. Right lateral the North Anatolian (NAFZ), the Kırıkkale-Erbaa (KEFZ), and the Eskisehir Fault Zones (EFZ) are major strike-slip neotectonic elements in the region. The triangle shaped area bounded with these fault zones has many contractional structures such as tectonic wedges, folds, and blind thrusts.

The Eldivan-Elmadag Pinched Crustal Wedge (EPCW), having a thrusted eastern and normal faulted western margin and composed of the Neo-Tethyan suture zone rocks, is a main NNE-trending contractional structure in the area between the NAFZ and the KEFZ. The EPCW has been active since Late Pliocene as indicated by the age of the syn-tectonic Deyim formation and the seismic activity. The other NNE-trending wedge structure called Abdusselam Wedge (ASLW), having a thrusted eastern and normal faulted western margin similar to the EPCW, is located between Ayas and Kazan in west of Ankara. The ASLW deforms the Middle Miocene-Pliocene sedimentary rocks. The normal faults on the western margin of the ASLW create drag fold synclines whereas on the eastern side thrusts and blind thrusts produce a NNE-trending large-scale folding. Apart from these major wedges, asymmetrical folding on the Oligocene sedimentary units probably created by the NNE-trending blind thrusts is seen at the east of the EPCW around Bagdatli. All these contractional structures are limited by the regional strike-slip faults namely the NAFZ, KEFZ and EFZ. They are compatible with the recent GPS based regional geodetic strain analyses and microseismic activity which indicate active NW-SE compressional regime in North Central Anatolia.

SESSION NO. 15, 14:30

Monday, 4 October 2010

Tectonic, magmatic & geomorphic evolution of high plateaus. Part 1 (*Yüksek platolarin tektonik, magmatik ve jeomorfik evrimleri*)

METU Convention and Cultural Centre, Salon C

15-1 14:30 Mo, Xuanxue

CENOZOIC MAGMATISM IN GANGDESE, SOUTHERN TIBET: RECORDS OF COLLISION AND SUBDUCTION BETWEEN INDIA AND ASIA

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The geological record of Cenozoic magmatism in Gangdese (Lhasa terrane), southern Tibet, provides unique information on the collisional and postcollisional processes following the collision and partial subduction of India beneath Asia. The Linzizong volcanic succession (LVS, ~65-45 Ma) and the coeval batholiths (~60-40 Ma) of andesitic to rhyolitic composition represent a magmatic response to the India-Asia continental collision, which began ~70-65 Ma and culminated at ~45-40 Ma with convergence continuing to the Present. These syncollisional felsic magmatic rocks are widely distributed along much of the 1500 km long Gangdese Belt immediately north of the India-Asia suture (Yarlung-Zangbo) in southern Tibet. Our study of the Linzizong volcanic rocks from the Linzhou Basin (near Lhasa) suggests that syncollisional felsic magmatism likely accounts for much of the continental crustal growth in this collision zone. These volcanic rocks show a first-order temporal change from the andesitic lower Dianzhong Formation (64.4–60.6 Ma), to the dacitic middle Nianbo Formation (~54 Ma), and to the rhyolitic upper Pana Formation (48.7–43.9 Ma). Our detailed geochemical study suggests that the remarkable compositional similarity between the andesitic lower Dianzhong Formation and the modal bulk continental crust corroborates our proposal that continental collision zones may be the sites of net crustal growth (juvenile crust) through process of syncollisional felsic magmatism (Mo et al. 2007, 2008). Undeformed, subaerial LVS volcanic strata unconformably overlie the strongly deformed Cretaceous strata in the Gangdese Belt, providing an important temporal constraint for the timing of widespread volcanism in the region. Recent 1:250,000-scale geological mapping of the Gangdese Belt (Pan et al. 2004) revealed that the LVS occurs widely, extending E-W for more than 1500 km and taking up ~50% of the outcrop area in the entire Gangdese Belt. This unconformity goes with the LVS throughout the entire Gangdese Belt, suggesting a major tectonic event, which, together with the geochronological data (Dong, 2002; Mo et al., 2002, 2003; Zhou et al., 2004; Mo et al., 2006, 2007 allows us to advocate that the unconformity, which is ≥65 Ma, represents the onset of the India-Asia collision, supporting the inferred timing of initial collision at ~70–65 Ma by Yin and Harrison (2000) based on a multitude of observations. Postcollisional potassic and ultrapotassic rocks (28-8 Ma) reveal the mantle contribution to their source regions and the involvement of recycled subducted Indian continental material in response to the post-collisional lithosphere delamination (Mo et al., 2006; Zhao et al., 2009). The 14-18 my old volcanic rocks and adakitic ore-bearing granite porphyries, on the other hand, possibly represent the products of partial melting of the thickened lower crust of the plateau. The chronological order and geochemical characteristics of these magmatic events point to the processes of Tethyan oceanic crust subduction, followed by India-Asia collision and subsequent continental subducting/underthrusion of India beneath southern Tibet. This tectonic scenario is reminiscent of that of the eastern Mediterranean region, involving the collision of Africa with Eurasia in the late Cenozoic, offering new insights into the magmatism and crust accretion associated with continental collision, which may also suggest a common tectono-magmatic pathway for the evolution of continental collision zones.