MADEN TETKİK VE ARAMA
GENEL MÜDÜRLÜĞÜ

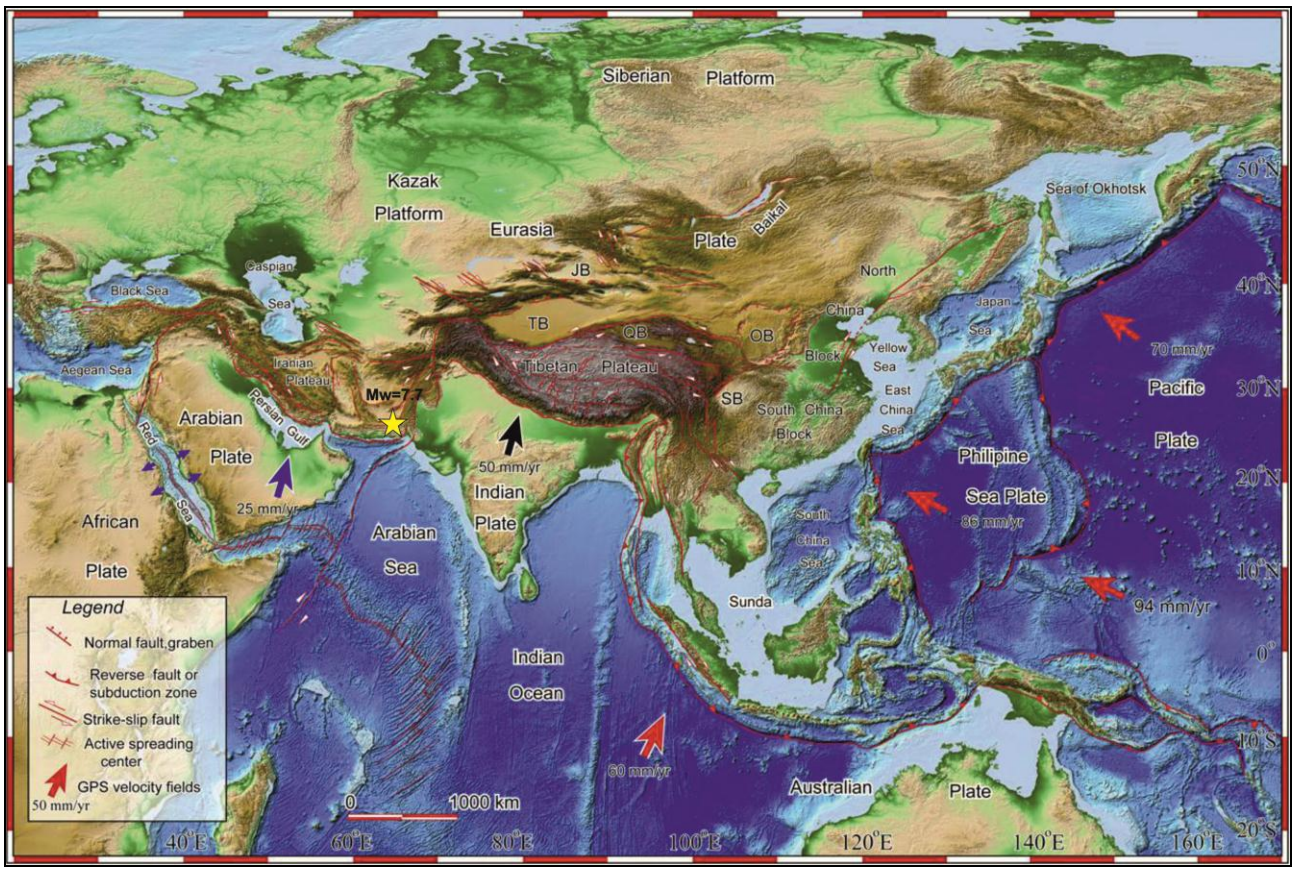
24 EYLÜL 2013 BALOCHİSTAN (PAKİSTAN) DEPREMİ (Mw=7.7) BİLGİ NOTU

JEOLOJİ ETÜTLERİ DAİRESİ
Yer Dinamikleri Araştırma ve Değerlendirme Koordinatörlüğü
Aktif Tektonik Araştırmaları Birimi

24 EYLÜL 2013

ANKARA

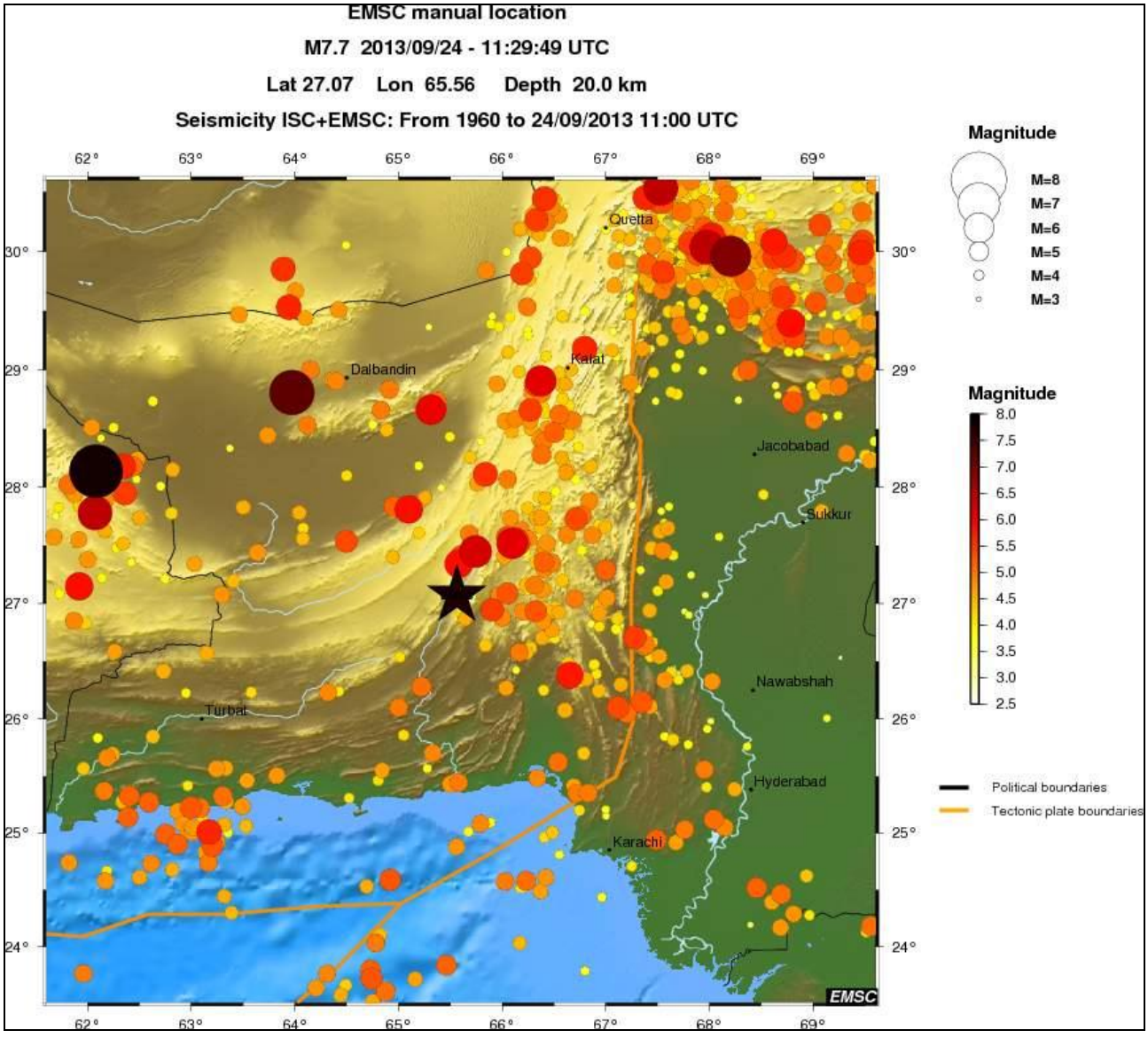
Kandilli Rasathanesi ve Deprem Araştırma Enstitüsü (KRDAE) kayıtlarına göre, 24 Eylül 2013 tarihinde Pakistan'n Awaran yerleşim biriminin 65 km kuzeydoğusundaki Balochistan bölgesinde yerel saat ile 14:29'da (UTC: 11:29) M_w: 7.7 büyüklüğünde bir deprem meydana gelmiştir (Şekil 1). EMSC kayıtlarına göre depremin koordinatları 27.07 K ve 65.56 D, odak derinliği ise 20 km olarak önerilmektedir. Deprem başta İran ve Pakistan olmak üzere, Afganistan, Ortadoğu ve Körfez ülkelerinde kuvvetlice hissedilmiştir. Bu depreme ilişkin değişik kaynaklardan derlenen sismolojik bilgiler Tablo 1'de verilmiştir.



Şekil 1. 24 Eylül 2013 Balochistan (Pakistan) Depremi dış merkezinin (USGS) bölgeye ait basitleştirilmiş tektonik haritadaki yeri. Faylar; Armijo vd., 1986, 1989; Avouac ve Tapponnier, 1993; Burchfiel vd., 1995; Fu vd., 2004; Peltzer ve Tapponnier, 1988; Walker ve Jackson, 2004; Tapponnier ve Molnar, 1979; Tapponnier vd., 2001; Taylor ve Yin, 2009; Yin, 2010'dan derlenmiştir. Avrasya Levhası'na göre diğer levhaların göreli hareket GPS hız vektörleri Wang vd. 2001; Sella vd., 2002; Zhang vd., 2004; Allmendinger vd., 2007 ve Vergnolle vd., 2007'den derlenmiştir. JB: Jungar Havzası, QB: Qaidam Havzası, SB: Sichuan Havzası, TB: Tarım Havzası'nı göstermektedir. Sarı yıldız; deprem dış merkezini göstermektedir.

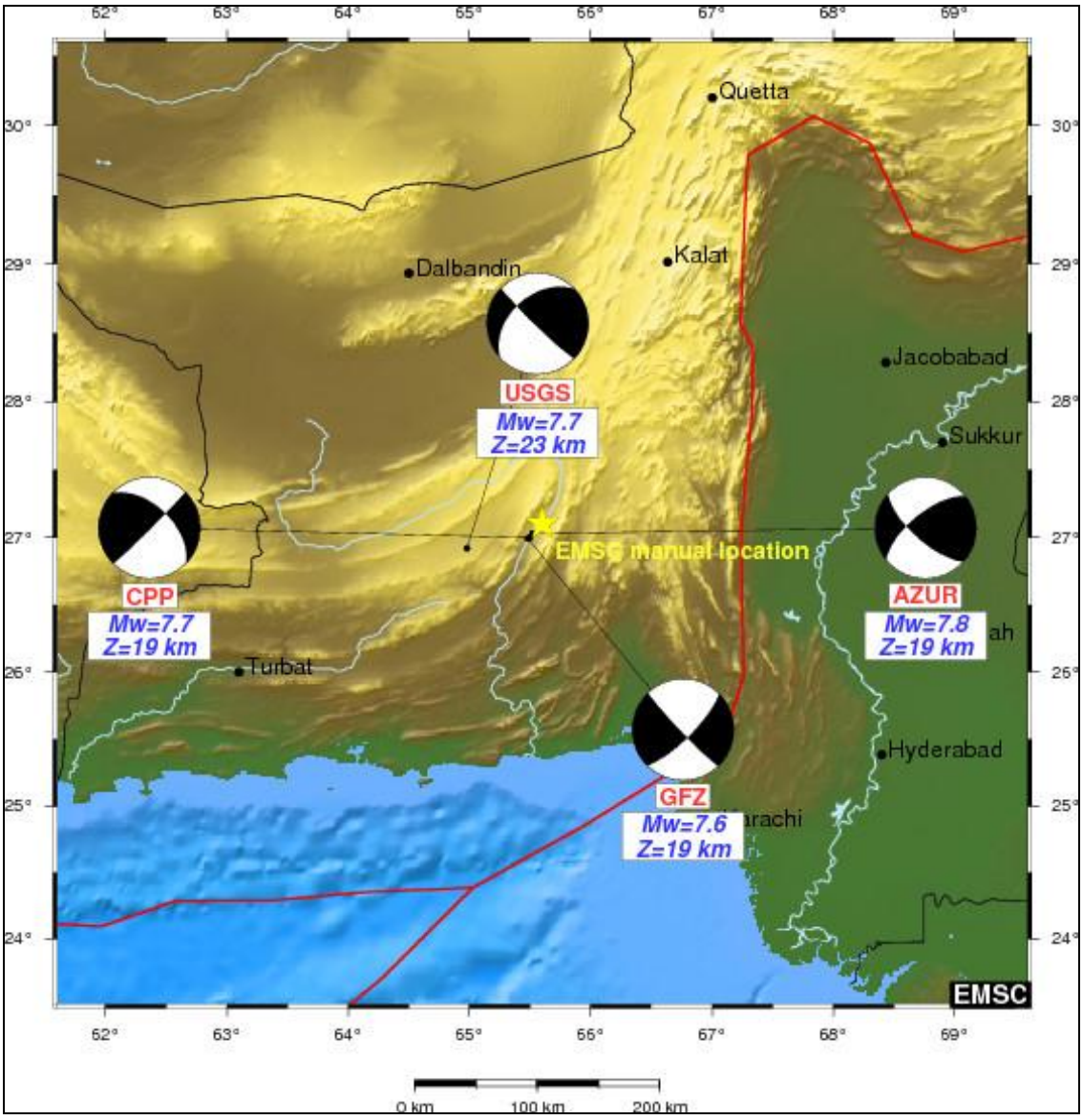
Tablo 1. 24 Eylül 2013 Balochistan (Pakistan) Depremi'nin değişik kaynaklara göre deprem parametreleri (EMSC: European-Mediterranean Seismological Centr; USGS: United States Geological Survey)

Kaynak	*Tarih*	*Saat*	*Koordinat*		*Derinlik (km)*	*Büyüklük*			
			Enlem (K)	*Boylam (D)*		M_W	M_d	M_L	M_b
EMSC	24.09.2013	11:29:49 (UTC)	27.07	65.56	20	7.7	-	-	-
USGS	24.09.2013	11:29:480 (UTC)	27.00	65.51	20	7.7	-	-	



Şekil 2. 24 Eylül 2013 Balochistan (Pakistan) Depremi dış merkezi ve yakın civarının 1960-Günümüz depremsellik haritası. Siyah yıldız, 24 Eylül 2013 Deprem dış merkezini göstermektedir.
(http://www.emsc-csem.org/Images/EVID/33/335/335667/335667.regional.seismicity.mag.jpg)

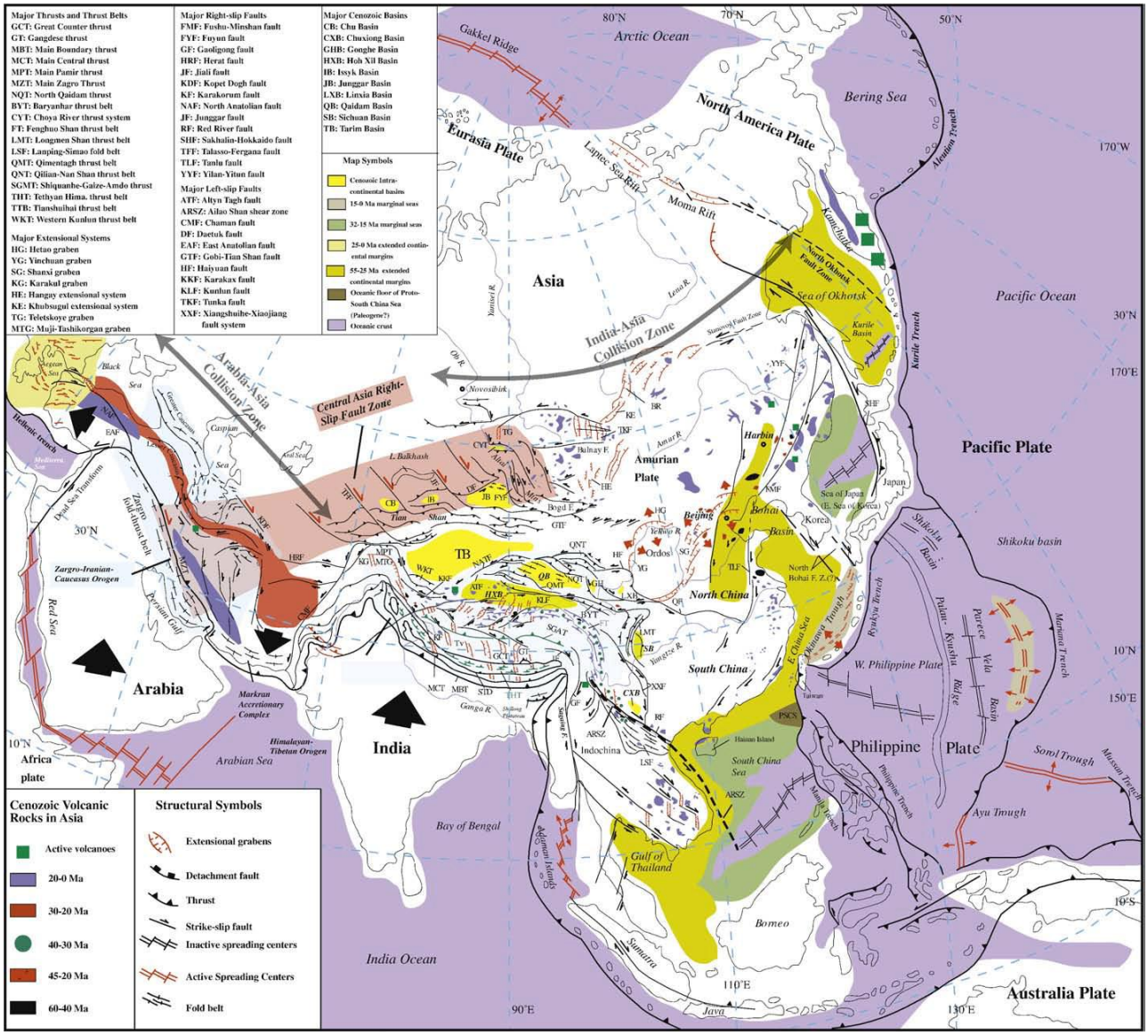
24 Eylül 2013 depremi, depremsellik açısından aktif bir alanda meydana gelmiştir (Şekil 2). Çeşitli sismoloji merkezleri tarafından yapılan hızlı odak mekanizması çözümleri, depremin doğrultulu atımlı bir faylanma mekanizmasıyla geliştiğini göstermektedir (Şekil 3).



Şekil 3. 24 Eylül 2013 Balochistan (Pakistan) depreminin çeşitli sismoloji merkezleri tarafından önerilen lokasyonu ve hızlı fay düzlemi çözümleri (http://www.emsc-csem.org/Images/EVID/33/335/335667/335667.MT.jpg)

Deprem bölgesi ve çevresindeki ana tektonik unsurlar Şekil 4'te sunulmuştur. 24 Eylül 2013 depreminin, Arabistan - Asya dalma-batma kuşağının gerisinde (Makran yığışım kompleksi) süregelen sıkışmalı tektonik rejimde gelişmiş doğrultu atımlı fay sistemlerinden biri olan, KD- gidişli sol yanal Chaman Fay Sistemi'nden kaynaklandığı düşünülmektedir. Chaman Fay Sistemi Pakistan'dan Afganistan'a kadar uzanan yaklaşık 900 km uzunluğunda sol yanal doğrultu atımlı bir fay sistemidir ve bu sistem aynı zamanda Hindistan ve Avrasya Levhaları arasındaki transform

levha sınırını oluşturur. Chaman Fay Sistemi üzerindeki yıllık kayma hızı jeolojik çalışmalara göre 25-35 mm/yıl, küresel levha kinematiği çalışmalarına göre ise 40 mm/yıl olarak önerilmektedir.



Şekil 4. Bölgedeki Senozoyik yapıları ve volkanik kayaların dağılımını gösterir harita. Haritadaki magmatik kayaçların yaş verileri aşağıdaki kaynaklardan derlenmiştir; Kuzey Çin; Wang, 1982; Ye vd., 1987; Zhou vd., 1988; Liu vd., 1992, Liu vd., 2001; Yakın doğu Rusya; Okamura vd., 1998; Baykal rift sistemi, Rasskazov (1994); Mongolia; Whitfotd-Stark, 1987; Traynor ve Sladen, 1995; Barry ve Kent, 1998; Cunningham, 2005; Orta ve Doğu Tibet; Pan vd., 1990, Yu, 1991; Turner vd., 1993; Deng, 1998; Chung vd., 1998, 2005; Wang vd., 2001; Pamir ve Karakurum Dağları; Ratschbacher vd., 1994; Murphy vd., 2002; Robinson vd., 2004; Murphy ve Copeland, 2005; Robinson vd., 2007; GD Çin; Liu vd., 1992; Ho vd., 2000, 2003; GD Tibet; Yin vd., 1994,1999a; Miller vd., 1999; Williams vd., 2001; Lee vd., 1998; İran; Berberian ve Berberian, 1981.

Yararlanılan Kaynaklar:

Allmendinger, R.W., Reilinger, R., Loveless, J., 2007. Strain and rotation rate from GPS in Tibet, Anatolia, and the Altiplano. Tectonics 26, TC3013. doi:10.1029/ 2006TC002030.

Armijo, R., Tapponnier, P., Merccier, J.L., Han, T.L., 1986. Quaternary extension in southern Tibet: field observations and tectonic implications. Journal of Geophysical Research 91, 13083–13872.

Armijo, R., Tapponnier, P., Han, T.L., 1989. Late Cenozoic right-lateral strike-slip faulting in southern Tibet. Journal of Geophysical Research 94, 2787–2838.

Avouac, J.P., Tapponnier, P., 1993. Kinematic model of active deformation in central Asia. Geophysical Research Letters 20, 895–898.

Barry, T.L., Kent, R.W., 1998. Cenozoic magmatism in Mongolia and the origin of central and east Asian basalts. In: Flower, M.F.J., Chung, S.L., Ho, C.H., Lee, T.Y. (Eds.), Mantle dynamics and plate interactions in East Asia. InAGU,Washington D.C., pp. 347–364.

Berberian, F., Berberian, M., 1981. Tecto-plutonic episodes in Iran. In: Gupta, H.K., Delany, F.H. (Eds.), "Zagros-Hindu Kush-Himalaya Geodynamic Evolution". In: Geodynamics Series, vol. 3. American Geophysical Union, pp. 5–32.

Burchfiel, B.C., Chen, Z.L., Liu, Y.P., Royden, L.H., 1995. Tectonics of the Longmen Shan and adjacent regions, central China. International Geology Review 37, 661–735.

Chung, S.L., Lo, C.C., Lee, T.Y., Zhang, Y., Xie, Y., Li, X., Wang, K.L., Wang, P.L., 1998. Diachronous uplift of the Tibetan plateau starting 40 Myr ago. Nature 394, 769–773.

Chung, S.L., Chu, M.F., Zhang, Y.Q., Xie, Y.W., Lo, C.H., Lee, T.Y., Lan, C.Y., Li, X.H., Zhang, Q., Wang, Y.Z., 2005. Tibetan tectonic evolution inferred from spatial and temporal variations in post-collisional magmatism. Earth Sci. Rev. 68, 173–196.

Cunningham, D., 2005. Active intracontinental transpressional mountain building in the Mongolian Altai: defining a new class of orogen. Earth Planet. Sci. Lett. 240, 436–444.

Deng, W.M., 1998. Cenozoic Intraplate Volcanic Rocks in the Northern Qinghai-Xizang Plateau. Geologic Publishing House, Beijing. (in Chinese with English abstract).

Fu, B.H., Ninomiya, Y., Lei, X.L., Toda, S., Awata, Y., 2004. Mapping active fault associated with the 2003 Mw 6.6 Bam (SE Iran) earthquake with ASTER 3D images. Remote Sensing of Environment 92, 153–157.

Ho, K.S., Chen, J.C., Juang,W.S., 2000. Geochronology and geochemistry of late Cenozoic basalts from the Leiqiong area, southern China. J. Asian Earth Sci. 18, 307–324.

Ho, K.S., Chen, J.C., Lo, C.H., Zhao, H.L., 2003. Ar-40–Ar-39 dating and geochemical characteristics of late Cenozoic basaltic rocks from the Zhejiang–Fujian region, SE China: eruption ages, magma evolution and petrogenesis. Chem. Geol.197, 287–318.

Lee, T.Y., et al., 1998. 40Ar/39Ar dating result of Neogene basalts in Vietnam and its tectonic implications. In: Flower, M.F.J., Chung, S.L., Ho, C.H., Lee, T.Y. (Eds.), "Mantle Dynamics and Plate Interactions in East Asia". InAGU,Washington D.C., pp. 317–330.

Liu, R.X., Chen, W.J., Sun, J.Z., Li, D.M., 1992. K–Ar ages and tectonic setting of Cenozoic volcanic rocks of China. In: Liu, R.X. (Ed.), "Cenozoic Volcanic Rocks of China: Geochronology and Geochemistry", pp. 1–43.

Liu, J.Q., Han, J.T., Fyfe,W.S., 2001. Cenozoic episodic volcanism and continental rifting in northeast China and possible link to Japan Sea development as revealed from K–Ar. Tectonphys. 339, 385–401.

Miller, C., Schuster, R., Klotzli, U., Frank, W., Purtscheller, F., 1999. Post-collisional potassic and ultrapotassic magmatism in SW Tibet: Geochemical and Sr–Nd–Pb–O isotopic constraints for mantle source characteristics and petrogenesis. J. Petrology 40, 1399–1424.

Murphy, M.A., Copeland, P., 2005. Transtensional deformation in the central Himalaya and its role in accommodating growth of the Himalayan orogen. Tectonics 22, 1029. doi:10.1029/2001TC001332.

Murphy, M.A., Yin, A., Kapp, P., Harrison, T.M., Manning, C.E., Ryerson, F.J., Ding, L., Guo, J.H., 2002. Structural evolution of the Gurla Mandhata detachment system, southwest Tibet: implications for the eastward extent of the Karakoram fault system. Geol. Soc. Am. Bull. 114, 428–447.

Okamura, S., Martynov, Y.A., Furuyama, K., Nagao, K., 1998. K–Ar ages of the basaltic rocks from Far East Russia: constraints on the tectono-magmatism associated with the Japan Sea opening. Island Arc 7, 271–282.

Pan, G., Wang, P., Xu, Y., Jiao, S., Xiang, L., 1990. Cenozoic tectonic evolution of the Qinghai–Xizang Plateau. Geol. Publishing House, Beijing.

Peltzer, G., Tapponnier, P., 1988. Formation and evolution of strike slip faults, rifts, and basins during the India–Asia collision: an experimental approach. Journal of Geophysical Research 315, 15085–15117.

Rasskazov, S.V., 1994. Magmatism related to the eastern Siberia rift system and the geodynamics. Bulletin des Centres de Recherches Exploration Production Elf Aquitaine, vol. 18, pp. 437–452.

Ratschbacher, L., Frisch, W., Liu, G., Chen, C., 1994. Distributed deformation in southern and western Tibet during and after the India–Asia collision. J. Geophys. Res. 99, 19,817–19,945.

Robinson, A.C., Yin, A., Manning, C.E., Harrison, T.M., Zhang, S.H., Wang, X.F., 2004. Tectonic evolution of the northeastern Pamir: constraints from the northern portion of the Cenozoic Kongur Shan extensional system, western China. Geol. Soc. Amer. Bull. 116, 953–973.

Robinson, A.C., Yin, A., Manning, C.E., Harrison, T.M., Zhang, S.H., Wang, X.F., 2007. Cenozoic evolution of the eastern Pamir: implications for strain-accommodation mechanisms at the western end of the Himalayan–Tibetan orogen. Geol. Soc. Amer. Bull. 119, 882–896.

Sella, G.F., Dixon, T.H., Mao, A., 2002. REVEL: a model for recent plate velocities from space geodesy. Journal of Geophysical Research 107, B2081. doi:10.1029/2000JB000033.

Tapponnier, P., Molnar, P., 1979. Active faulting and Cenozoic tectonics of Tien Shan, Mongolia, and Baikal regions. Journal of Geophysical Research 84, 3425–3459.

Tapponnier, P., Xu, Z.Q., Roger, F., Meyer, B., Arnaud, N., Wittlinger, G., Yang, J.S., 2001. Geology oblique stepwise rise and growth of the Tibet plateau. Science 294, 1671–1677.

Taylor, M.H., Yin, A., 2009. Active structures of the Himalayan–Tibetan orogen and their relationships to earthquake distribution, contemporary strain field, and Cenozoic volcanism. Geosphere 5, 199–214.

Traynor, J.J., Sladen, C., 1995. Tectonic and stratigraphic evolution of the Mongolian People's Republic and its influence on hydrocarbon geology and potential. Mar. Petrol. Geol. 12, 35–52.

Turner, S., Hawkesworth, C.J., Liu, J., Rogers, N., Kelley, S., van Calsteren, P., 1993. Timing of Tibetan uplift constrained by analysis of volcanic rocks. Nature 364, 50–53.

Vergnolle, M., Calais, E., Dong, L., 2007. Dynamics of continental deformation in Asia. Journal of Geophysical Research 112. doi:10.1029/2006JB004807 (B11403).

Ye, H., Zhang, B.T., Mao, F.Y., 1987. The Cenozoic tectonic evolution of the Great North China: two types of rifting and crustal necking in the Great North China and their tectonic implications. Tectonophys. 133, 217–227.

Yin, A., 2010. Cenozoic tectonic evolution of Asia: a preliminary synthesis. Tectonophysics 488, 293–325.

Yin, A., Harrison, T.M., Ryerson, F.J., Chen, W., Kidd, W.S.F., Copeland, P., 1994. Tertiary structural evolution of the Gangdese thrust system in southern Tibet. J. Geophys. Res. 99 (18), 175–18,201.

Yin, A., Harrison, T.M., Murphy, M.A., Grove, M., Nie, S., Ryerson, F.J., Feng,W.X., Le, C.Z., 1999a. Tertiary deformation history of southeastern and southwestern Tibet during the Indo-Asian collision. Geol. Soc. Am. Bull. 111, 1644–1664.

Yu, X., 1991. The Haoti alkaline untrabasic volcanic rocks from Tancheng, Gansu province: a potassic ultramafic lamprophyre containing the upper mantle-derived xenolith and megacrystals (in Chinese with English abstract). Geological Review (in Chinese with English Abstract) 37, 144–153.

Wang, H.Z. (Ed.), 1982. Atlas of the Paleogeography of China. InChinese Cartographic Publishing House, Beijing. 85 pp.

Wang, Q., Zhang, P., Freymueller, J., Bilham, R., Larson, K., Lai, X., You, X., Niu, Z., Wu, J., Li, Y., Liu, J., Yang, Z., Chen, Q., 2001. Present-day crustal deformation in China constrained by global positioning system measurements. Science 294, 574–577.

Wang, J.H., Yin, A., Harrison, T.M., Grove, M., Zhang, Y., Xie, G., 2001. A tectonic model for Cenozoic magmatism in the eastern Indo–Asian collision zone. Earth Planet. Sci. Lett. 188, 123–133.

Walker, R., Jackson, J., 2004. Active tectonics and late Cenozoic strain distribution in central and eastern Iran. Tectonics 23. doi:10.1029/2003TC001529 (TC5010).

Whitfotd-Stark, J.L., 1987. A survey of volcanism on mainland Asia. Geol. Soc. Am. Spec. Pap 213, 1–74.

Williams, H., Turner, S., Kelley, S., Harris, N., 2001. Age and composition of dikes in Southern Tibet: new constraints on the timing of east-west extension and its relationship to postcollisional volcanism. Geol. 29, 339–342.

Zhang, P.Z., Shen, Z.K., Wang, M., Gan, W.J., Burgmann, R., Molnar, P., Wang, Q., Niu, Z.J., Sun, J.B., Wu, J., Sun, H., You, X., 2004. Continuous deformation of the Tibetan Plateau from global positioning system data. Geology 32, 809–812.

Zhou, X.H., Zhu, B.Q., Liu, R.X., Chen,W.J.,1988. Cenozoic basaltic rocks in eastern China. In: Macdougall, J.D. (Ed.), "Continental Flood Basalts". InKluwer Academic Publishers.