



This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No [308417]".



New Directions in Seismic Hazard Assessment through Focused Earth Observation in the Marmara Supersite

Grant Agreement Number: 308417

co-funded by the European Commission within the Seventh Framework Programme

THEME [ENV.2012.6.4-2]

[Long-term monitoring experiment in geologically active regions of Europe prone to natural hazards: the Supersite concept]

D7.2

GIS database of the fault parameters

Project Start Date	1 November 2012
Project Duration	42 Months
Project Coordinator /Organization	Nurcan Meral Özel / KOERI
Work Package Number	WP 7
Deliverable Name/ Number	GIS database of the fault parameters/ D 7.2
Due Date Of Deliverable	30 April 2016
Actual Submission Date	2 May 2016
Organization/Author (s)	ITU / Cengiz Zabcı -CEREGE / Pierre Henry, Julia Kende, Celine Grall

Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission)	
RE	Restricted to a group specified by the consortium (including the Commission)	
CO	Confidential, only for members of the consortium (including the Commission)	

Table of Contents

Introduction	3
References for the fault map and related information (Appendix II of the GIS files)	6

Introduction

In the frame of this study, both the offshore and inland faults were compiled and/or remapped by using various studies or the interpretation of new data and integrated into a GIS database. Active faults of the Marmara Region are not only vectorised, but also each line segment is accompanied with several attributes, which make it possible to have several classifications based on several criteria, such as their activity (Figure 1) and their depth span (Figure 2).

The attribute table includes several key information such as; (a) fault name, (b) fault type, (c) fault class, (d) strike, (e) dip, (f) the precision of dip angle, (g) category of faulting according to their depth span, (h) coordinates of starting and ending of each line segment, (i) length, (j) geological estimates of horizontal and vertical slip rates, (k) geodetical constraints of horizontal and vertical slip rates, (l) and references. The explanatory details of all these attributes and references of used information are provided as Appendix files (Table 1 and Reference List) together with ESRI Shapefiles.

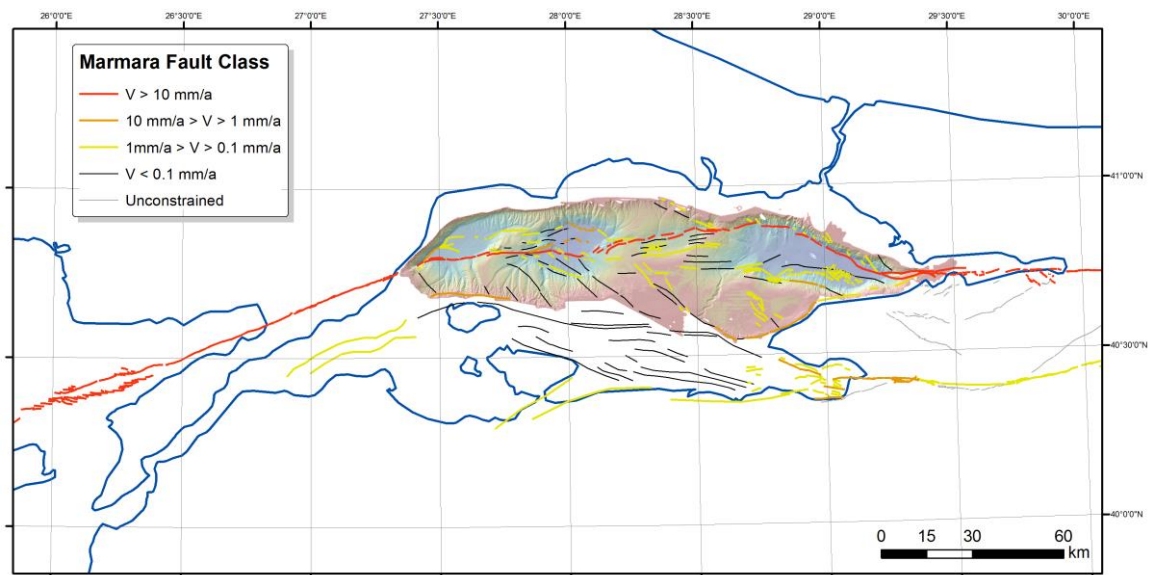


Figure 1. Classification of faults according to their activity level

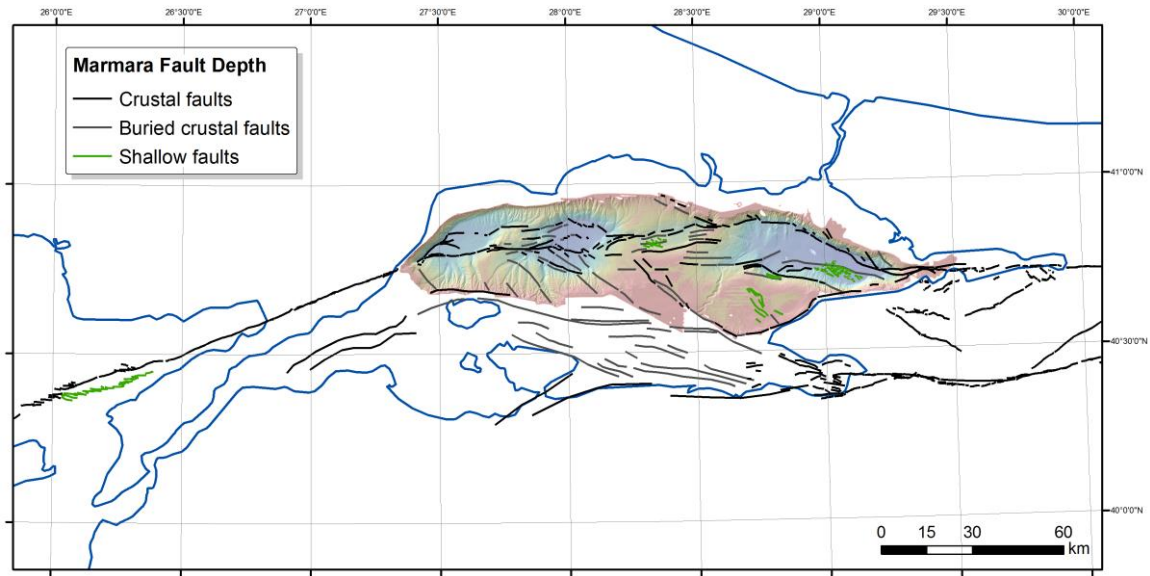


Figure 2. Classification of faults according to the depth span

Table 1. Explanation of attribute table of ESRI Shapefile of active faults (Appendix I)

LAYER NAME	DATA TYPE	SCALE
Marmara_Faults.shp	Vector-Polyline	-

FIELD	FULL NAME	FIELD TYPE	COMMENTS
F_NAM	Fault or segment name	TEXT (Length: 50)	Name of the specific segment or fault - if it exist (e.g. Ganos segment, Main Marmara Fault)
F_TYP	Fault Type	TEXT (Length: 4)	Fault types will be classified with abbreviations. SSF: Strike-slip, NSSF: Oblique Strike-Slip fault with normal component, RSSF: Oblique strike-slip fault with reverse components, NF: Normal Fault, RF: Reverse Fault
F_CLASS	Fault Class	TEXT (Length: 1)	Fault classes by order of the magnitude of slip velocity (V) (A: $V > 10$ mm/a, B: 10 mm/a $> V > 1$ mm/a, C: 1 mm/a $> V > 0.1$ mm/a, D: $V < 0.1$ mm/a, E: Unsonstrained)
STRIKE	Fault strike angle	SHORT INTEGER (Precision: 3)	Fault strike angle in degrees (e.g. 126)
DIP	Fault dip angle	SHORT INTEGER (Precision: 2)	Fault dip angle in degrees (e.g. 85)

MARSite (GA 308417) D7.2 GIS database of the fault parameters

FIELD	FULL NAME	FIELD TYPE	COMMENTS
DIP_CAT	Dip angle precision	TEXT (Length: 1)	Precision of the constrained dip angle (A: Well constrained, B: Poorly constrained, C: Unconstrained)
DEPTH	Fault Categories according to their depth span	SHORT INTEGER (Precision: 1)	Fault categories which are classified according to their depth span (1: Crustal/Lithospheric faults, 2: Blind or buried crustal/lithospheric faults, 3: Synsedimentary faults and shallow splays)
X_START	X coordinate of fault start	DOUBLE (Precision:11/Scale:7)	The starting X coordinate of the fault in decimal degrees and WGS84 map datum (e.g. 27.4569877)
Y_START	Y coordinate of fault start	DOUBLE (Precision:11/Scale:7)	The starting Y coordinate of the fault in decimal degrees and WGS84 map datum (e.g. 39.7456981)
X_END	X coordinate of fault end	DOUBLE (Precision:11/Scale:7)	The ending X coordinate of the fault in decimal degrees and WGS84 map datum (e.g. 27.4569877)
Y_END	Y coordinate of fault end	DOUBLE (Precision:11/Scale:7)	The ending Y coordinate of the fault in decimal degrees and WGS84 map datum (e.g. 39.7456981)
LENGTH	Length of the fault	DOUBLE (Precision:10/Scale:3)	Length of the fault in meters (e.g. 12567.234)
GEO_HRATE	Horizontal geologic slip-rate	TEXT (Length: 20)	The measured horizontal geologic slip-rate of the fault in mm/a scale (e.g. 17.7±3.3; NaN for unknown)
GEO_VRATE	Vertical geologic slip-rate	TEXT (Length: 20)	The measured vertical geologic slip-rate of the fault in mm/a scale (e.g. 7±1; NaN for unknown)
GEOD_HRATE	Horizontal geodetic slip-rate	TEXT (Length: 20)	The measured/modeled horizontal geodetic slip-rate of the fault set in mm/a scale (e.g. 18.5±0.5, NaN for unknown)
GEOD_VRATE	Vertical geodetic slip-rate	TEXT (Length: 20)	The measured/modeled vertical geodetic slip-rate of the fault set in mm/a scale (e.g. 18.5±0.5, NaN for unknown). (+) are for closing, and (-) for opening
REF	References	TEXT (Length: 20)	Numbered references about used parameters. Full reference list is provided with Appendix II (e.g. 1, 2, 3, 4).

References for the fault map and related information (Appendix II of the GIS files)

- Aksoy, M. E., M. Meghraoui, M. Vallée, and Z. Çakır (2010), Rupture characteristics of the A.D. 1912 Mürefte (Ganos) earthquake segment of the North Anatolian fault (western Turkey), *Geology*, 38(11), 991-994, doi:10.1130/g31447.1.
- Aksoy, M. E., Meghaoroui, M., Çakır, Z., Ferry, M., and Uçarkuş, G., Short-term and long-term slip rate along the westernmost segment of the North Anatolian Fault using paleoseismic trenching and drainage offsets, in Proceedings EGU, Vienna, 2010, Volume 12, Geophysical Research Abstracts, p. EGU2010-12447.
- Akyüz, H. S., Hartleb, R., Barka, A., Altunel, E., and Sunal, G., 2002, Surface rupture and slip distribution of the 12 November 1999 Düzce Earthquake (M 7.1), North Anatolian Fault, Bolu, Turkey: *Bulletin of the Seismological Society of America*, v. 92, p. 61-66.
- Ambraseys, N. N., and Zatopek, A., 1969, The Mudurnu valley, west Anatolia, Turkey, earthquake of 22 July 1967: *Bulletin of the Seismological Society of America*, v. 59, no. 2, p. 521-589.
- Armijo, R., B. Meyer, S. Navarro, G. King, and A. Barka (2002), Asymmetric slip partitioning in the sea of Marmara pull-apart: A clue to propagation processes of the North Anatolian Fault?, *Terra Nov.*, 14, 80–86, doi:10.1046/j.1365-3121.2002.00397.x.
- Armijo, R. et al. (2005), Submarine fault scarps in the Sea of Marmara pull-apart (North Anatolian Fault): Implications for seismic hazard in Istanbul, *Geochemistry, Geophys. Geosystems*, 6, 1–29, doi:10.1029/2004GC000896.

- Barka, A., Akyüz, H. S., Altunel, E., Sunal, G., Çakır, Z., Dikbaş, A., Yerli, B., Armijo, R., Meyer, B., De Chabaliér, J. B., Rockwell, T., Dolan, J. R., Hartleb, R., Dawson, T., Christofferson, S., Tucker, A. Z., Fumal, T. E., Langridge, R., Stenner, H. D., Lettis, W., Bachhuber, J., and Page, W. D., 2002, The surface rupture and slip distribution of the 17 August 1999 İzmit earthquake (M 7.4), North Anatolian Fault: Bulletin of the Seismological Society of America, v. 92, p. 43-60.
- Bécel, A., M. Laigle, B. de Voogd, A. Hirn, T. Taymaz, S. Yolsal-Cevikbilen, and H. Shimamura (2010), North Marmara Trough architecture of basin infill, basement and faults, from PSDM reflection and OBS refraction seismics, Tectonophysics, 490, 1–14, doi:10.1016/j.tecto.2010.04.004.
- Demirbağ, E., C. Rangin, X. Le Pichon, and a. M. C. Şengör (2003), Investigation of the tectonics of the Main Marmara Fault by means of deep-towed seismic data, Tectonophysics, 361, 1–19, doi:10.1016/S0040-1951(02)00535-8.
- Dikbaş, A., Akyüz, H. S., Meghraoui, M., Ferry, M., Yalciner, C. C., Zabcı, C., Karabacak, V., Kıyak, N., and Altunel, E., Kuzey Anadolu Fay Zonu'nun batı kesiminde Sapanca-Akyazı segmentinin son 1000 yıllık deprem tarihçesi ve kayma hızı (Earthquake history and slip-rate of Sapanca-Akyazı segment on western of north anatolian fault for the past 1000 years), in Proceedings 62. Türkiye Jeoloji Kurultayı, Ankara, 2009, p. 1000-1001.
- Emre, Ö., Awata, Y., and Duman, T. Y., 2003, 17 Ağustos 1999 İzmit Depremi Yüzey Kırığı/Surface Rupture Associated with the 17 August 1999 İzmit Earthquake: Ankara, MTA Genel Müdürlüğü Special Publication 1, p. 280.

- Emre, Ö., Duman, T. Y., and Özalp, S., 2011, 1:250,000 Scale Active Fault Map Series of Turkey, Adapazarı (NK36-13) Quadrangle. Serial Number 14: General Directorate of Mineral Research and Exploration.
- Emre, Ö., Duman, T. Y., and Özalp, S., 2011, 1:250,000 Scale Active Fault Map Series of Turkey, Bursa (NK36-12) Quadrangle. Serial Number 9: General Directorate of Mineral Research and Exploration.
- Gasperini, L., Polonia, A., Çağatay, M. N., Bortoluzzi, G., and Ferrante, V., 2011, Geological slip rates along the North Anatolian Fault in the Marmara region: *Tectonics*, v. 30, no. 6, p. TC6001.
- Gasperini, L., Polonia, A., Bortoluzzi, G., Henry, P., Le Pichon, X., Tryon, M., Çağatay, N., and Géli, L., 2011, How far did the surface rupture of the 1999 İzmit earthquake reach in Sea of Marmara?: *Tectonics*, v. 30, no. 1, p. TC1010.
- Görür, N., and Ş. Elbek (2013), Tectonic events responsible for shaping the Sea of Marmara and its surrounding region, *Geodin. Acta*, (January), 1–11, doi:10.1080/09853111.2013.859346.
- Grall, C., P. Henry, D. Tezcan, B. Mercier de Lepinay, a. Becel, L. Geli, J.-L. Rudkiewicz, T. Zitter, and F. Harmegnies (2012), Heat flow in the Sea of Marmara Central Basin: Possible implications for the tectonic evolution of the North Anatolian fault, *Geology*, 40(1), 3–6, doi:10.1130/G32192.1.
- Grall, C., Henry, P., Thomas, Y., Westbrook, G. ., Cagatay, M. ., Marsset, B., ... Géli, L. (2013). Slip rate estimation along the western segment of the Main Marmara 1 Fault over the last 405-490 ka by correlating Mass Transport Deposits. *Tectonics*.

- Hergert, T., Heidbach, O., Bécél, A., & Laigle, M. (2011). Geomechanical model of the Marmara Sea region-I. 3-D contemporary kinematics. *Geophysical Journal International*, 185(3), 1073–1089. doi:10.1111/j.1365-246X.2011.04991.x
- Imren, C., X. Le Pichon, C. Rangin, E. Demirbag, B. Ecevitoglu, and N. Görür (2001), The North Anatolian fault within the Sea of Marmara: a new evaluation based on multichannel seismic and multibeam data, *Earth Planet. Sci. Lett.*, 186, 143–158.
- Ketin, İ. (1969), Kuzey Anadolu Fayı Hakkında, *Maden Tetkik ve Arama Dergisi*, 72, 1-27.
- Konca, A. O., Leprince, S., Avouac, J.-P., and Helmberger, D. V., 2010, Rupture Process of the 1999 Mw 7.1 Duzce Earthquake from Joint Analysis of SPOT, GPS, InSAR, Strong-Motion, and Teleseismic Data: A Supershear Rupture with Variable Rupture Velocity: *Bulletin of the Seismological Society of America*, v. 100, no. 1, p. 267-288.
- Kondo, H., Özaksoy, V., and Yıldırım, C., 2010, Slip history of the 1944 Bolu-Gerede earthquake rupture along the North Anatolian fault system: Implications for recurrence behavior of multisegment earthquakes: *J. Geophys. Res.*, v. 115, no. B4, p. 1-16.
- Kozacı, Ö., Altunel, E., Clahan, K., Yönlü, Ö., Sundermann, S. T., Lettis, W. R., Turner, J., Alterkruse, J., Gümüş, S., and Lindvall, S. C., A Late Holocene Slip Rate of the North Anatolian Fault, Hersek Peninsula, İzmit Bay, Turkey, in *Proceedings AGU Fall Meeting, San Francisco, 2010, AGU*, p. T33B-2236.
- Kurt, H., Sorlien, C. C., Seeber, L., Steckler, M. S., Shillington, D. J., Cifci, G., ... Carton, H. (2013). Steady late quaternary slip rate on the Cinarcik section of the North Anatolian fault near Istanbul, Turkey. *Geophysical Research Letters*, 40, n/a–n/a. doi:10.1002/grl.50882.

- Le Pichon, X. et al. (2001), The active Main Marmara Fault, *Earth Planet. Sci. Lett.*, 192, 595–616, doi:10.1016/S0012-821X(01)00449-6.
- Meghraoui, M., Aksoy, M. E., Akyüz, H. S., Ferry, M., Dikbaş, A., and Altunel, E., 2012, Paleoseismology of the North Anatolian Fault at Güzelköy (Ganos segment, Turkey): Size and recurrence time of earthquake ruptures west of the Sea of Marmara: *Geochem. Geophys. Geosyst.*, v. 13, p. Q04005.
- Öztürk, K., C. Yaltrak, and B. Alpar (2009), The relationship between the tectonic setting of the Lake İznik Basin and the middle strand of the North Anatolian Fault, *Turkish Journal of Earth Sciences*, 18, 209-224.
- Polonia, A., Gasperini, L., Amorosi, A., Bonatti, E., Bortoluzzi, G., Cagatay, N., Capotondi, L., Cormier, M. H., Gorur, N., McHugh, C., and Seeber, L., 2004, Holocene slip rate of the North Anatolian Fault beneath the Sea of Marmara: *Earth and Planetary Science Letters*, v. 227, no. 3-4, p. 411-426.
- Pucci, S., Palyvos, N., Zabcı, C., Pantosti, D., and Barchi, M., 2006, Coseismic ruptures and tectonic landforms along the Düzce segment of the North Anatolian Fault Zone (Ms 7.1, November 1999): *Journal of Geophysical Research*, v. 111, p. B06312-B06312.
- Pucci, S., Pantosti, D., Barchi, M. R., and Palyvos, N., 2007, A complex seismogenic shear zone: The Düzce segment of North Anatolian Fault (Turkey): *Earth and Planetary Science Letters*, v. 262, no. 1–2, p. 185-203.
- Pucci, S., De Martini, P. M., and Pantosti, D., 2008, Preliminary slip rate estimates for the Düzce segment of the North Anatolian Fault Zone from offset geomorphic markers: *Geomorphology*, v. 97, no. 3-4, p. 538-554.

- Rangin, C., X. Le Pichon, E. Demirbag, and C. Imren (2004), Strain localization in the Sea of Marmara: Propagation of the North Anatolian Fault in a now inactive pull-apart, *Tectonics*, 23, 1–18, doi:10.1029/2002TC001437.
- Reilinger, R., McClusky, S., Vernant, P., Lawrence, S., Ergintav, S., Cakmak, R., Ozener, H., Kadirov, F., Guliev, I., Stepanyan, R., Nadariya, M., Hahubia, G., Mahmoud, S., Sakr, K., ArRajehi, A., Paradissis, D., Al-Aydrus, A., Prilepin, M., Guseva, T., Evren, E., Dmitrotsa, A., Filikov, S. V., Gomez, F., Al-Ghazzi, R., and Karam, G., 2006, GPS constraints on continental deformation in the Africa-Arabia-Eurasia continental collision zone and implications for the dynamics of plate interactions: *Journal of Geophysical Research*, v. 111.
- Rockwell, T., Regona, D., Seitz, G., Langridge, R., Aksoy, M. E., Uçarkuş, G., Ferry, M., Meltzner, A. J., Meghraoui, M., Satir, D., Barka, A., and Akbalık, B., 2009, Paleoseismology of the North Anatolian Fault near the Marmara Sea: Implications for fault segmentation and seismic hazard, in Reicherter, K., Michetti, A. M., and Silva, P. G., eds., *Paleoseismology: Historical and Prehistorical Records of Earthquake Ground Effects for Seismic Hazard Assessment*: London, The Geological Society, p. 31-54.17
- Seeber, L., Emre, O., Cormier, M.-H., Sorlien, C. C., McHugh, C., Polonia, A., Cagatay, N. (2004). Uplift and subsidence from oblique slip: the Ganos–Marmara bend of the North Anatolian Transform, western Turkey. *Tectonophysics*, 391(1-4), 239–258. doi:10.1016/j.tecto.2004.07.015
- Seeber, L., Cormier, M.-H., McHugh, C., Emre, O., Polonia, A., & Sorlien, C. C. (2006). Rapid subsidence and sedimentation from oblique slip near a bend on the North Anatolian transform fault in the Marmara Sea, Turkey. *Geology*, 34(11), 933. doi:10.1130/G22520A.1

- Sorlien, C. C., Akhun, S. D., Seeber, L., Steckler, M. S., Shillington, D. J., Kurt, H., ... Diebold, J. B. (2012). Uniform basin growth over the last 500ka, North Anatolian Fault, Marmara Sea, Turkey. *Tectonophysics*, 518-521, 1–16. doi:10.1016/j.tecto.2011.10.006
- Şengör, A. M. C., C. Grall, C. İmren, X. Le Pichon, N. Görür, P. Henry, H. Karabulut, and M. Siyako (2014), The geometry of the North Anatolian transform fault in the Sea of Marmara and its temporal evolution: implications for the development of intracontinental transform faults 1, *Can. J. Earth Sci.*, 51(3), 222–242, doi:10.1139/cjes-2013-0160.
- Ustaömer, T., Gökaşan, E., Tur, H., Görüm, T., Batuk, F., Kalafat, D., Alp, H., Ecevitoglu, B., and Birkan, H., 2008, Faulting, mass-wasting and deposition in an active dextral shear zone, the Gulf of Saros and the NE Aegean Sea, NW Turkey: *Geo-Marine Letters*, v. 28, no. 3, p. 171-193.