Cuaternario y Geomorfología
ISSN: 0214-1744

www.rediris.es/CuaternarioyGeomorfologia/

Roman, Visigothic and Islamic evidence of earthquakes recorded in the archaeological site of "El Tolmo de Minateda" (Prebetic Zone, southeast of Spain)

Evidencias de terremotos Romanos, Visigóticos e Islámicos en el yacimiento arqueológico de "El Tolomo de Minateda" (Zona Prebética, sureste de España)

Rodríguez-Pascua, M.A.[(1)]; Abad Casal, L.[(2)]; Pérez-López, R.[(1)]; Gamo Parra, B.[(3)]; Silva, P.G.[(4)]; Garduño-Monroy, V.H.[(5)]; Giner-Robles, J.L.[(6)]; Perucha, M.A.[(1)]; Israde-Alcántara, I.[(5)]; Bischoff, J.[(7)]; Calvo, J.P.[(8)]

(1) Departamento de Investigación y Prospectiva Geocientífica, Instituto Geológico y Minero de España. C/ Ríos Rosas, 23. 28003-Madrid. SPAIN. E-mail: ma.rodriguez@igme.es, r.perez@igme.es, ma.perucha@igme.es
(2) Universidad de Alicante. Facultad de Filosofía y Letras. Dpto. de Prehistoria, Arqueología, Filología Griega y Filología Latina. Carretera Sant Vicent del Raspeig s/n. 03690 Sant Vicent del Raspeig – Alicante. SPAIN. E-mail: lorenzo.abad@ua.es
(3) Museo de Albacete. Junta de Comunidades de Castilla-La Mancha. Parque de Abelardo Sánchez, s/n. 02002-Albacete. SPAIN. E-mail: bgamo@jccm.es
(4) Dpto. Geología Universidad Salamanca, Escuela Politécnica Superior de Ávila, 05003-Ávila. SPAIN. E-mail: pgsilva@usal.es
(5) Universidad Michoacana. Morelia. Michoacán, 58060 MEXICO. E-mail: vgmonroy@zeus.umich.mx, aisrade@zeus.umich.mx
(6) Dpto. Geología. Facultad de Ciencias. Universidad Autónoma de Madrid. Cantoblanco. Tres Cantos. Madrid. SPAIN. E-mail: jlginer@gmail.es
(7) Laboratory of Geochronology. United States Geological Survey. 345 Middlefield Road, MS 211, Menlo Park, CA 94025. USA. E-mail: jbischoff@usgs.gov
(8) Departamento de Petrología. Facultad de CC. Geológicas. Univ. Complutense de Madrid. jpcalvo@ucm.es

Resumen:

El yacimiento arqueológico de El Tolmo de Minateda está localizado en la provincia de Albacete (SE de España) y muestra un registro continuo de ocupación desde hace 3500 años. A pesar de esto, el yacimiento presenta tres intervalos temporales sin registro arqueológico, todos ellos relacionados con súbitos e injustificados abandonos de la ciudad (s. I, s. VII y s. IX-X AD). Los efectos arqueológicos de terremotos (EAEs) observados sustentan la hipótesis de que se hayan podido producir terremotos de intensidad moderada a fuerte que provocaron los distintos abandonos del yacimiento: caídas orientadas de columnas, muros y arcos colapsados, abandono de los sistemas de irrigación e instalaciones de abastecimiento de agua, cerámica aplastada y en posición de caída, etc. A pesar de la falta de sismicidad histórica e instrumental en la zona,

estudios paleosísmicos llevados a cabo en la zona (Tobarra) sugieren la presencia de fallas activas en la zona (Falla de Pozohondo) afectando a sedimentos cuaternarios (aluviales, coluviales y lacustres). En este artículo proponemos la posibilidad de que tres terremotos de magnitudes moderadas destruyeron la ciudad romana de *Ilunum* (s. I AD), la visigótica de *Elo* (s. VII AD) y la islámica de *Madinat Iyih* (s. IX-X AD), siendo todas ellas el mismo lugar: El Tolmo de Minateda.

Palabras clave: periodo Romano; periodo Visigótico; periodo Islámico; terremoto; El Tolmo de Minateda (SE de España).

Abstract:

The archaeological site of "El Tolmo de Minateda" is located within the Albacete province (SE of Spain) and shows a continuous time record of ancient civilizations from 3500 yr BP onwards. However, three temporal gaps were identified in this archaeological record, all of them in relationship with a sudden and unclear abandonment of the city (Centuries 1st, 7th and 9-10th). The Archaeological Earthquake Effects (EAEs) supports the possibility that moderate to strong earthquakes were the cause of such abandonments: oriented columns fallen, collapsed walls and arches, abandonment of irrigation systems and fresh-water supplies, crashed pottery, etc. Despite of the scarce of instrumental seismicity and a few historical chronicles, paleoseismic studies performed in the neighbouring zone (Tobarra) suggest the presence of closer seismic sources as faults (Pozohondo Fault) affecting Quaternary alluvial, lacustrine deposits and colluviums. In this work, we propose the possibility that three moderate earthquakes devastated the ancient Roman city of Ilunum (Century 1st AD), the Visigothic city of Elo (Century 7th AD) and the Islamic city of Madinat Iyih (Century 9th-10thAD), all of them the same place: "El Tolmo de Minateda".

Key words: Roman; Visigothic; Islamic; Earthquake; "Tolmo de Minateda" (SE Spain).

1. Introduction

"El Tolmo de Minateda" is one of the best representative archaeological sites within the Albacete province (SE Spain), with a well-preserved record for the last c.a. 3500 years BP. During this epoch, various cultures and ancients civilizations were settled in this site, in parallelism with the historical periods of the Iberian Peninsula: Iberians, Romans, Byzantines, Muslims and Christians. The "El Tolmo de Minateda" represents a strategically geographical point between the Iberian Meseta and the Mediterranean zone, and this explains the ongoing and well-preserved archaeological record. During this period of almost 3500 yrs, "El Tolmo" shows three abandonments and destructions in three different ages: Roman (Century 1st-5th AD), Visigoth (Century 7th AD) and Islamic (Century 9th AD). The seismic activity of the active faults in this zone could have affected the archaeological site and produce the lack of record in these three historic periods.

2. Geographycal and Geological setting

"El Tolmo de Minateda" is located between the villages of Cordovilla and Agramon, at the southernmost area of the Albacete province (SE of Spain) (Figure 1A). This archaeological site appears close to the Betic Cordillera and is related with two major strike-slip faults, Pozohondo and Lietor (Figure 1B). Both structures are active faults trending NW-SE, affecting Quaternary alluvial and colluviums deposits and with a trace longitude about 90 km approximately (Rodríguez-Pascua *et al*., 2003).

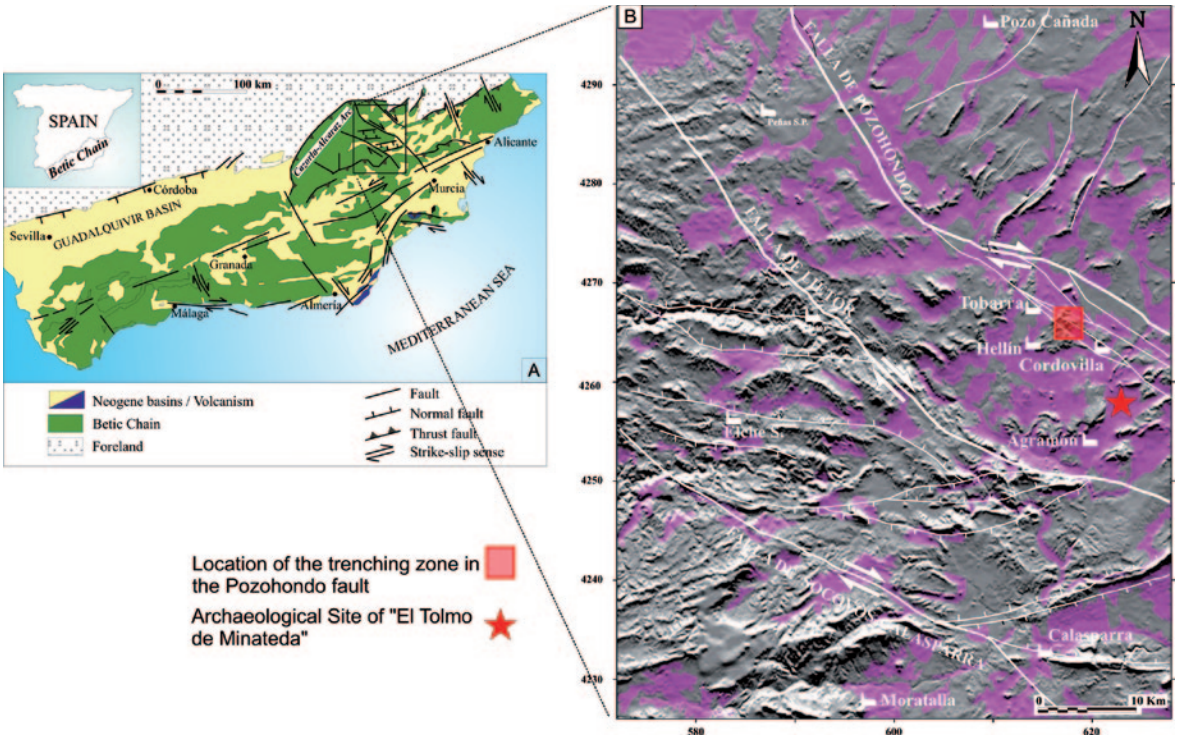

Figure 1. (A) Geographic location of the studied area. (B) Detailed structural map of the archaeological site of the ancient city "Tolmo de Minateda" (red star) (Albacete province). Socovos-Calasparra, Lietor and Pozohondo faults represent major strike-slip faults with palaeoseismic evidence of recent activity and the location of the trenches in the Pozohondo Fault (dashed square).

Figura 1. (A) situación geográfica del área de estudio. (B) mapa estructural de detalle de la localización del yacimiento arqueológico de El Tolmo de Minateda (estrella roja) (Provincia de Albacete). Las fallas de Socovos, Lietor y Pozohondo representan las mayores fallas de desgarre de la zona con evidencias de actividad paleosismica reciente y la localización de las trincheras realizadas en la falla de Pozohondo (recuadro rojo, Rodríguez Pascua et al., 2012)

3. Earthquake Archaeological Effects (EAEs)

The archaeological record of this ancient city supports evidence for earthquake damage linked to three periods of city abandonment and destruction, including oriented collapse of walls, watchtowers and columns, oriented cracking of walls and column drums, as well as "in situ" broken pottery, abrupt abandonment of kilns, and anomalous sedimentary infilling of canals and water supply facilities (Abad-Casal, 1998). Additionally, large scale rock landslides containing Visigothic carved tombs are also apparently associated with some of these episodes, constituting one of the few geo-archaeological earthquake ground effects reported in this zone. Using this information, we had compiled a set of Earthquake Archaeological Effects (EAEs) according to the classification of Rodríguez-Pascua *et al*. (2011).

3.1. EAEs during the Roman Period (Century 1st-5th AD)

In the High Roman Empire this zone was moderately occupied by people, however some evidence supports the idea that the principal city of Ilunum was deserted (Roman name of the "El Tolmo"). Evidences of this abandonment include the partial detritical infilling of the fresh-water supply and irrigation canals in the Zama town (close to Ilunum), as well as the increasing population dispersion outwards from the site (Abad-Casal, 1998). As potential coseismic effects, both the solid defensive wall and the watchtowers in the en-

trance of the city collapsed (Figure 2), and it is possible identify penetrative fractures across the in-situ remained stone blocks.

3.2. EAEs during the Visigothic Period (Century 7th AD)

During the middle Visigothic Period (Century 7th AD), there is a lack of archaeological record associated with an unexplained abandonment of El Tolmo, (named as Elo during this period) (Abad-Casal *et al*. (1998)). Associated to this abandonment and as potential coseismic effects, the defensive wall at the "El Reguerón", as well as part of the City Wall collapsed. The watchtowers in the entrance of the city collapsed again (Figure 2), and there are penetrative fractures across the in situ remained stone blocks. Furthermore, this collapse was dipping not towards the main dip slope direction. This wall was founded on the solid Miocene sandstone, being the main way through the city gate and which displays a continuous deep wheel-tracks, carved on the sandstone substratum.

During the Visigoth period, a Basilica was built at the top of the town (Abad Casal *et al*., 2000). The Basilica was also damaged, coeval with the wall collapse, showing fallen columns with an approximate N-S trending, and fallen north. The arches of the main nave of the basilica and the principal vault was also collapsed (Figure 3). Moreover, the key stone of the arch appeared in a vertical position and there are cracks dipping 45° and affecting the Basilica pillars. These types of cracks have been cited as possible coseismic effects by other works (e.g. Silva *et al*., 2009).

Figure 2. Collapsed defensive wall dated in the Visigothic period.
Figura 2. Colapso de la muralla defensiva datada en época visgoda.

Figure 3. Collapsed arch of the Visigothic Basilica.
Figura 3. Arco colapsado de la Basílica visigoda.

3.3. EAEs during the Islamic Period (Century 9th AD)

In this period, a part of the city was reconstructed on the Visigothic ruins and by the Moslem and was called as Madinat Iyih (Gutiérrez-Lloret, 2000). The eventual abandonment of the city was inferred from the lack of any archaeological record between the 9th and 10th centuries AD. Moreover, multiple pottery artifacts were destroyed by walls collapses in the interior of the buildings (Figure 4). In fact, the whole of the ceramic district collapsed during this period.

Historical documents suggest possible seismic geological effects affecting to the ground water level. Carmona González (1998) cited these documents and told that the springs of the "El Tolmo" were dried by the Christians and appeared 50 km southward from this site. This effect is common during an earthquake, amply documented and registered in the ESI-07 scale (Michetti *et al*. 2007; Silva *et al*. 2008).

Other geological effects of this possible earthquake are the large landslides affecting anthropomorphic tombs carved by the Visigoths (Figure 5). This large landslide corresponds to the south part of the butte, and is more recent than those preserved in the northern slope connected with the Visigothic episode of destruction. The wasted sandstone blocks appear weakly weathered and uncovered by colluviums. Scars on the cliff are fresh scarps, with nearly vertical free-faces displaying a very poor lichen evolution. Individual mobilized blocks can reach dimensions of about 4000 m^3, and the total mobilized material at the northern slope comprises 500 m^3.

In order to illustrate the landsliding susceptibility of the butte cliffs, it can be said that some historical reports seem to indicate that landslide scars were presumably reactivated as far-field effects from the well-known Lisbon earthquake (1755 AD). An historic chronicle from the close village of Agramon (Figure 1B for location) literally reported: "*de una montaña se desprendió mucha parte*" (a large part of a mountain collapsed; Martínez-Solares, 2001), and there are many more historic reports for the 1755 event mentioning similar gravitational processes in this zone.

Figure 4. Fragmented in situ Islamic pottery by dropped wall stones.
Figura 4. Alfarería fragmentada in situ por la caída de bloques de piedra procedentes de los muros circundantes.

Figure 5. Rock fall whit anthropomorphic Visigothic tombs.
Figura 5. Caída de bloques con tumbas antropomórficas visigóticas.

4. Paleoseismic evidences

Several palaeoseismological studies close to "El Tolmo" (within the 15 km of radius) revealed active seismic sources in the surroundings (Rodríguez-Pascua *et al*., 2008, 2009 y 2010; Pérez-López *et al*., 2009). The closest seismic source corresponds to the Pozohondo Fault, a NW-SE trending strike-slip and ca 90 km long (see Figure 1 for location). In detail, this fault exhibits an active segment, the Tobarra-Cordovilla segment (15 km length), which shows a complex graben basin affecting Quaternary lacustrine deposits and displaying well-preserved coseismic fault scarps with large cracks of metric scale affecting recent soils.

Furthermore, the present landscape along this fault segment is controlled by active faulting, with the occurrence of a dammed lake caused by the obstruction of the drainage by Late Pleistocene to Holocene surface ruptures. Rodríguez-Pascua *et al*. (2008) obtained a relative dating of the youngest fault scarp using the scarp diffusion equation, calibrated for the semi-arid climate of SE Spain (Pérez-López *et al*., 2007), ranging between the ages 3 BC and 920 AD, and with the highest likelihood about 500-700 AD. Recent trench digging in this fault shows the last important earthquake aged by radiocarbon in between the Century 1^{st} – 4^{th} AD (Rodríguez-Pascua *et al*., 2012).

5. Conclusions

The Figure 6 resumes the tentative proposal of the historic evolution of "EL Tolmo de

Minateda" from archaeoseismic studies. Three possible earthquakes affected this archaeological site (Figure 6). The first earthquake occurred in the High Roman Empire (Centuries 1st-2th AD). The city collapsed and it was abandoned. Paleoseismological studies in the Pozohondo Fault (10 km northward) indicate one earthquake of 6<M<7, dated in the Century 1st AD by radiocarbon measurements. We propose this ancient earthquake as a possible cause for the massive desertion of Ilunum. The second one occurred during the Visigothic period (Century 7th AD), the city of Elo was destroyed and showing documented damage: oriented fallen columns, collapsed arches, cracks dipping 45° in the masonry blocks, etc. The last earthquake probably occurred during the Islamic period (Centuries 9th). In this case the archaeoseismological evidences are based on the collapse of the city of Madinat Iyih (pottery destroyed in situ, etc.) and secondary earthquake ground effects as large landslide affecting anthropomorphic tombs of Visigoth era (*post-quem*). The assumed damage of the "El Tolmo" from the last two earthquakes, suggests that the epicentre could be located close to the ancient city but, until now, there is not paleoseismological evidence for the seismic source.

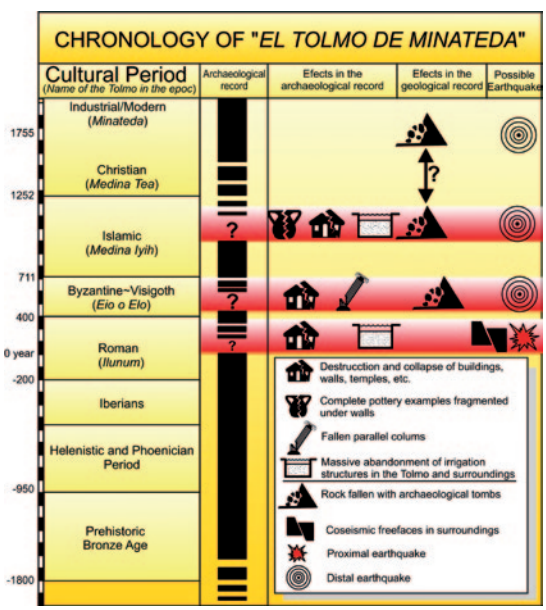

Figure 6. Chronological archaeoseismic scheme proposed for the ancient city of "Tolmo de Minateda". *Figura 6. Tabla cronológica arqueosísmica propuesta para el yacimiento arqueológico de El Tolmo de Minateda.*

Acknowledgements

This work is supported by the Spanish Projects: ACTISIS CGL2006-05001/BTE and ACI2008-0726.

References

Abad-Casal, L.; Gutiérrez-Lloret, S.; Sanz-Gamo, R. (1998). *El Tolmo de Minateda, una historia de tres mil quinientos años*. Ed. Junta de Comunidades de Castilla – La Mancha. Toledo. 161 p.

Abad-Casal, L.; Gutiérrez-Lloret, S.; Gamo-Parras, B. (2000). La basílica y el baptisterio del Tolmo de Minateda (Hellín, Albacete). *Archivo Español de Arqueología*, 73, pp. 193-221.

Carmona González, A. (1998). El noroeste murciano en época árabe. *Miscelánea Medieval Murciana*. Vol XXI-XXII. Años 1997-1998, p. 59-70.

Gutiérrez-Lloret, S. (2000). La identificación de Madinat Iyih y su relación con la sede episcopal Elotana. Nuevas perspectivas sobre viejos problemas. *Scripta in Honorem.* E. A. Llobregat, Alicante, pp. 481-501.

Martínez-Solares, J. M. (2001). *Los efectos en España del Terremoto de Lisboa (1 de noviembre de 1755)*. Ed. Dirección General del Instituto Geográfico Nacional. Madrid. 756 p.

Michetti A.M.; Esposito E.; Guerrieri L.; Porfido S.; Serva L.; Tatevossian R.; Vittori E.; Audemard F.; Azuma T.; Clague J.; Comerci V.; Gurpinar A.; Mc Calpin J.; Mohammadioun B.; Morner N.A.; Ota Y.; Roghozin E. (2007). Intensity Scale ESI 2007. In: Guerrieri L. & Vittori E. (Eds.): *Memorie Descrittive Carta Geologica d'Italia*, 74, Servizio Geologico d'Italia – Dipartimento Difesa del Suolo, APAT, Roma, 53 pp.

Pérez-López, R.; Rodríguez-Pascua, M.A.; Giner-Robles, J.L.; Calvo, J.P.; Garduño-Monroy, V.H.; Israde-Alcantara I.; Bischoff, J. (2007). Calibration of the diffusion constant (K_0) for dating coseismic fault scarps by using the diffusion equation: application to the Alboraj earthquake, Albacete, SE Spain. In: *Contribuciones al Estudio del Periodo Cuaternario*. J. Lario y P.G. Silva, eds., pp. 161-162. AEQUA, Ávila (España).

Pérez-López R., Rodríguez-Pascua, M. A.; Giner-Robles, J. L.; Martínez-Díaz, J. J.; Marcos-Nuez, A.; Silva, P.G.; Bejar, M.; Calvo, J.P. (2009). Speleoseismology and palaeoseismicity of Benis Cave (Murcia, SE Spain): coseismic effects of the 1999 Mula earthquake (mb 4.8). *Geological Society, London, Special Publications,* 316, 207-216.

Rodríguez-Pascua, M.A.; De Vicente, G.; Calvo, J.P.; Pérez-López, R. (2003). Similarities between recent seismic activity and paleoseismites during the Late Miocene in the External Betic Chain: relationship by "b" value and fractal dimension. *Journal of Structural Geology*, 25, 749-763.

Rodríguez-Pascua, M. A.; Pérez-López, R.; Calvo, J. P.; García del Cura, M. A. (2008). Recent seismogenic fault activity in a Late Quaternary closed-lake graben basin (Albacete, SE Spain). *Geomorphology*, 102, 169-178.

Rodríguez-Pascua, M.A.; Bischoff, J.; Garduño-Monroy, V.H.; Pérez-López, R.; Giner-Robles, J.L.; Israde-Alcántara, I.; Calvo, J.P.; Williams, R.W. (2009). Estimation of the tectonic slip-rate from Quaternary lacustrine facies within the intraplate Albacete province (SE of Spain). *Sedimentary Geology*, 222, 89-97.

Rodríguez-Pascua, M.A.; Silva, P.G.; Garduño-Monroy, V.H.; Pérez-López, R.; Israde-Alcántara, I.; Giner-Robles, J.L.; Bischoff, J.; Calvo, J.P. (2010). Ancient earthquakes from archaeoseismic evidence during the Visigothic and Islamic periods in the archaeological site of "Tolmo de Minateda" (SE of Spain). In: *Ancient Earthquakes* (Manuel Sintubin, Iain Stewart, Tina Niemi & Erhan Altunel, eds.). Geological Society of America, Special Paper, 471: 171-184.

Rodríguez-Pascua, M.A.; Pérez-López, R.; Silva, P.G.; Giner-Robles, J.L.; Garduño-Monroy, V.H.; Reicherter, K. (2011). A Comprehensive Classification of Earthquake Archaeological Effects (EAE) for Archaeoseismology. *Quaternary International*, 242(1), 20-30.

Rodríguez-Pascua, M.A.; Pérez-López, R.; Garduño-Monroy, V.H.; Giner-Robles, J.L.; Silva, P.G.; Perucha-Atienza, M.A.; Hernández-Madrigal, V.M.; Bischoff, J. (2012). Paleoseismic and geomorphologic evidence of recent tectonic activity of the Pozohondo Fault (Betic Cordillera, SE Spain). *Journal of Iberian Geology*, 38(1), 113-126.

Silva, P.G., Rodríguez-Pascua, M.A.; Pérez-López, R.; Bardají, T.; Lario, J.; Alfaro, P.; Martínez-Díaz, J.J.; Reicherter, K.; Giménez, J.; Giner, J.L.; Azañón, J.M.; Goy, J.L.; Zazo, C. (2008). Catalogación de los efectos geológicos y ambientales de los terremotos en España en la Escala ESI-2007 y su aplicación a los estudios paleosismológicos. *Geotemas*, 10, 318.

Silva, P. G.; Reicherter, K.; Grützner, C.; Bardají, T.; Lario, J.; Goy, J.L.; Zazo, C.; Becker-Heidmann P.; (2009). Surface and subsurface palaeoseismic records at the ancient Roman city of Baelo Claudia and the Bolonia Bay area, Cádiz (south Spain). *Geological Society, London, Special Publications,* 316, 93-121.