Solid Earth Discuss., 3, C493–C496, 2011
www.solid-earth-discuss.net/3/C493/2011/


Solid Earth Discussions



# *Interactive comment on* "Phanerozoic black shales and the Wilson Cycle" *by* J. Trabucho-Alexandre et al.

**J. Trabucho-Alexandre et al.**

joao.trabucho@durham.ac.uk

Received and published: 17 November 2011

Dear Dr Wagner,

Thank you for your review. Our answer to your comments is in line with that to Dr Wignall and Dr Jímenez Berrocoso. Indeed the stage of a basin in the Wilson Cycle is one element in defining whether black shales may preferentially develop in certain parts of a basin or not. Obviously, climate, dominant wind directions, oceanography, (local) nutrient supply, etc. are important as well. However, the Wilson Cycle is a fundamental element in the development of environments in which black shales may accumulate. We shall rewrite the manuscript where needed to address this problem in the perceived message of the manuscript.

The model presented in this study does not attempt to fully explain all evidence of organic matter-rich sediments. Rather, it attempts to incorporate all environments past and present in which black shale accumulation is possible, and show that in different stages of the Wilson Cycle specific environments are more prone to black shale deposition than others. Also the type of organic matter (terrestrial vs marine) often shows a relation with the Wilson Cycle. Whether black shales are deposited or not, and at which time in the basin development, also depends on basin morphology and on local processes (including climate, oceanography, etc.). The black shales studied by Gavrilov et al. (2003) indeed illustrate that the Wilson cycle, though being an important element for the character and distribution of black shales, by controlling the development of depositional environments, does not necessarily overpower the other factors that favour black shale deposition. In case of the black shales formed on the Russian platform at the Palaeocene-Eocene Boundary clearly the PETM transgression, the dissociation of methane hydrates (Dickens et al., 1995), the availability of nutrients and a favourable circulation system were of importance. Nevertheless, in the context of the Wilson Cycle the PETM indeed coincides with a period of tectonic activity. The rift-to-drift transition in the NE North Atlantic has been shown to be coeval to the release of greenhouse gases, and a link between these two processes has been offered (Storey et al., 2007). A similar situation was seen during the Toarcian (e.g. Trabucho Alexandre et al., in press).

Different basins may be in different stages of the Wilson Cycle; therefore, environments around the globe in which black shales may accumulate will indeed be present during much of the Phanerozoic. Although black shales were deposited throughout the Phanerozoic, 'widespread' black shale deposition is characteristic for specific intervals in the Phanerozoic. These intervals are associated with supercontinent breakup, increased volcanism (large igneous provinces, increase of ocean-ridge volume). Whether the term uniformitarianism is relevant in this particular context seems a philosophical rather than a practical question.



SED

3, C493–C496, 2011



Whilst higher frequency controls on oceanography and climate are important indeed (cf. van Buchem et al., 1995), we focus here on the development over longer timescales of the environments in which black shales preferentially accumulate. We argue that when correlating black shales horizons worldwide it should be taken into consideration in which environments and by which processes they were formed. With regard to the notion that local black shale formation such as on Demerara Rise during the Cretaceous, needs to be considered in a wider regional (climate) context we refer to Trabucho Alexandre et al. (2010) who showed that in the western tropical Atlantic off South America black shale formation in the young North Atlantic was favoured by the combination of a high sea level, a warm climate and nutrient availability due to LIP activity, all related to supercontinent breakup, in combination with the circulation within the basin that depended on its orientation and latitudinal position.

Yours sincerely,

João

Dickens, G.R., O'Neil, J.R., Rea, D.K., and Owen, R.M.: Dissociation of oceanic methane hydrate as a cause of the carbon isotope excursion at the end of the Paleocene. Paleoceanography, 10, 965–971, 1995.

Trabucho-Alexandre, J., Tuenter, E., Henstra, G.A., van der Zwan, K.J., van de Wal, R.S.W., Dijkstra, H.A., and de Boer, P.L.: The mid-Cretaceous North Atlantic nutrient trap: Black shales and OAEs. Paleoceanography, 25, PA4201, doi:10.1029/2010PA001925, 2010.

Trabucho-Alexandre, J., Dirkx, R., Veld, H., Klaver, G., and de Boer, P.L., Toarcian black shales in the Dutch Central Graben: record of energetic, variable depositional conditions during an oceanic anoxic event, Journal of Sedimentary Research, 82, doi:10.2110/jsr.2011.5, in press, 2012.

Storey, M., Duncan, R.A., and Swisher, C.C.: Paleocene–Eocene Thermal Maximum



SED

3, C493–C496, 2011

and the opening of the northeast Atlantic, Science, 316, 587–589, 2007.

van Buchem, F.S.P., de Boer, P.L., McCave, I.N., and Herbin, J.P.: The organic carbon distribution in Mesozoic marine sediments and the influence of orbital climatic cycles (England and the western north Atlantic), in: Paleogeography, paleoclimate, and source rocks, edited by Huc, A.Y., AAPG Studies in Geology, 303–335, 1995.

Interactive comment on Solid Earth Discuss., 3, 743, 2011.