[PS]Constraining Timing of South Caspian Basin Isolation and Source Rock Deposition Using Re-Os Geochronology on Black Shales of the Maikop Series, Eastern Azerbaijan*

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Abstract

The Oligocene-Miocene Maikop Series of Azerbaijan records a critical change in the regional paleogeography relating to the evolution of the Paratethys Sea. The deposition of discreet, organic -rich intervals of claystone within the Maikop Series directly relate to increased restriction and periodic isolation of the Paratethys Sea and its basins from open marine waters. Constraining the time of basin restriction would allow scientists to attribute basin restriction to the continued tectonic movement of the Arabian Plate to the northeast, or to the fall of sea level during the Messinian Salinity Crisis. The Maikop Series is also a key petroleum source rock interval for basins of the Paratethys Sea. Increasing the resolution of Maikop stratigraphy, specifically in relation to the preservation of organic matter, will aid in the development of predictive subsurface models. Timing constraints on the Maikop are notoriously difficult because it is primarily composed of clay-rich rocks that are largely devoid of diagnostic microfauna. While recent chemostratigraphic divisions of this 3 km thick package have been proposed and are effective in a rough division of the Maikop into individual members, new advances in Re-Os geochronology on black shales offer the hope of a more quantitative division of this strata. This study seeks to employ Re-Os geochronology on the discreet, organic-rich intervals of black shale in the Maikop Series of the Kura Depression in Eastern Azerbaijan with the hope of resolving the paleogeographic conditions of the Paratethys Sea and the effects on the preservation of organic matter in the Maikop Series.

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Constraining Timing of South Caspian Basin Isolation and Source Rock Deposition using Re-Os Geochronology on Black Shales of the Maikop Series, Eastern Azerbaijan

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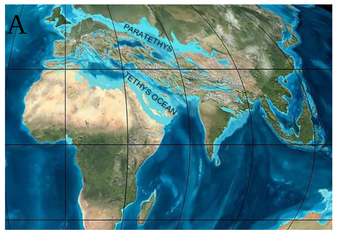
Abstract

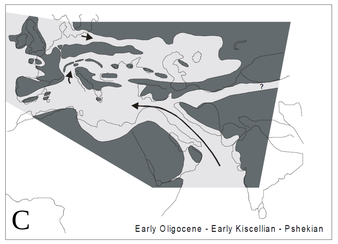
The Oligocene-Miocene Maikop Series of Azerbaijan records a critical change in the regional paleogeography relating to the evolution of the Paratethys Sea. The deposition of discreet, organic-rich intervals of claystone within the Maikop Series directly relate to increased restriction and periodic isolation of the Paratethys Sea and its basins from open marine waters. Constraining the time of basin restriction would resolve whether isolation resulted from tectonics in the Oligocene to Miocene or global sea level change during the global ice-house transition at the Eocene-Oligocene Transition (EOT). The Maikop Series is also a key petroleum source rock interval for basins of the Paratethys Sea. Increasing the resolution of Maikop stratigraphy, specifically in relation to the preservation of organic matter, will aid in the development of predictive subsurface models. Timing constraints on the Maikop are notoriously difficult because it is primarily composed of clay-rich rocks that are largely devoid of diagnostic microfauna. While recent chemostratigraphic divisions of this 3 km thick package have been proposed and are effective in a rough division of the Maikop into individual members, new advances in Re-Os geochronology on black shales offer the hope of a more quantitative division of this strata. This study seeks to employ Re-Os geochronology on the discreet, organic-rich intervals of black shale in the Maikop Series of the Kura Depression in Eastern Azerbaijan with the hope of resolving the paleogeographic conditions of the Paratethys Sea and the effects on the preservation of organic matter in the Maikop Series.

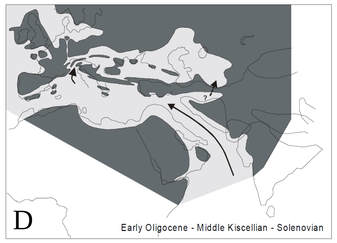
Geologic Background



B

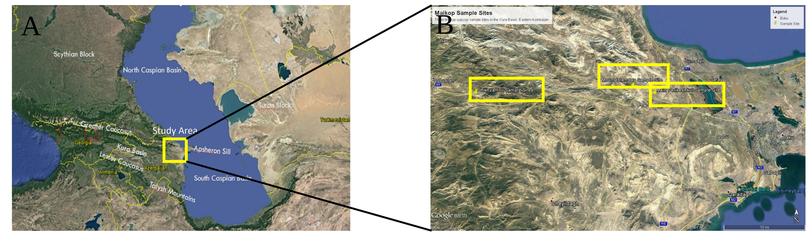
Period	Epoch		Age	Formation	Ma
Neogene	Miocene	M	Tarchanian	post Maikop	15
			Kotsakurian		
		E	Sakaraulian	Maikop Series	20
			Caucasian		25
Paleogene	Oligocene	L	Chattian		30
		E	Rupelian		35
	Eocene	L	Priabonian	Koun Formation	
		M	Bartonian		40

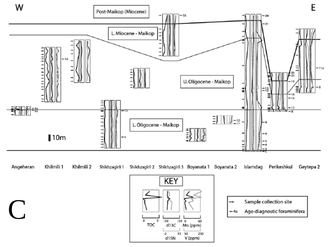




(A) Paleogeographic reconstruction of the Paratethys Sea at the EOT from Ron Blakey www2.nau.edu. The Paratethys is thought to have formed shortly before the EOT icehouse climate change. **(B)** Maikop deposition began at or just before the EOT and continued well into the Miocene (image from Hudson et al., 2008). **(C)** When the Paratethys formed, open seaways existed that allowed for the circulation of water between the Paratethys and the open ocean. Circulation pathways are indicated by arrows. Image from Rogl, 1999. **(D)** Periodic isolation of the Paratethys Sea is thought to have begun either at the EOT as a result of the global ice-house transition and the subsequent lowering of sea-level, resulting in the draining of marine seaways, or later during the Oligocene as a result of the northward movement of the Arabian and African plates causing uplift and restriction of seaways. Either way, the closure of marine seaways resulted in the development of water-column stratification and the subsequent preservation of organic matter. Image from Rogl, 1999.

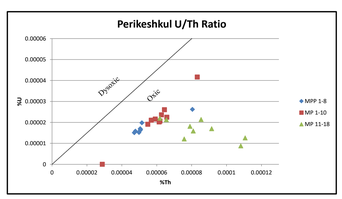
Study Area

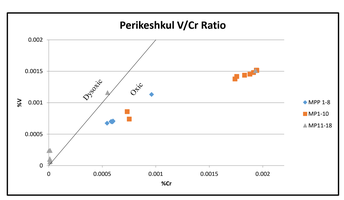




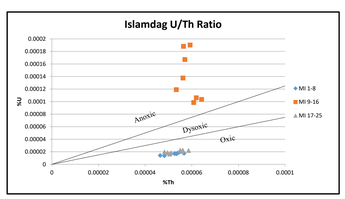
(A) The study area, highlighted with the yellow box, is in eastern Azerbaijan between the Greater Caucasus Mountains to the North and the Talysh Mountains to the South. Maikop outcrops in eastern Azerbaijan have been studied extensively because the Maikop is the primary source rock for the petroleum systems in Azerbaijan, including the Kura Basin and South Caspian Basin**. (B)** Three sample locations were chosen for this study, Perikeshkul, Mount Islamdag, and Shikhzahirli. These sites were chosen because they have been studied previously by other scientists, e.g. Popov et al., Hudson et al., & Efendiyeva et al. The stratigraphy (particularly the age) of these outcrops is still debated. **(C)** An example of one of the most current stratigraphic correlations performed on these outcrops, from Hudson et al., 2008. **(D)** Samples were taken from each lithological unit of interest in batches of eight, with little variation in vertical and horizontal distance between samples. Sampling was done in a manner to produce geochemically intact samples, and were taken in batches of eight in order to produce enough geochemical variation to produce a regression line for isotope geochronology.

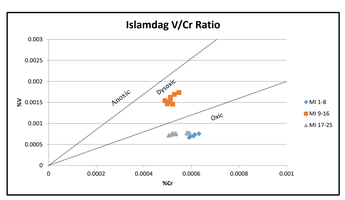
Perikeshkul



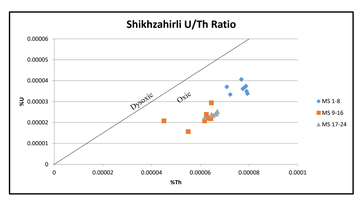


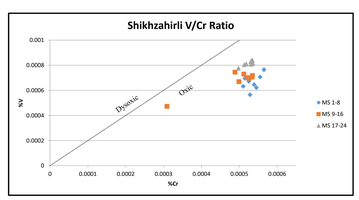
Islamdag





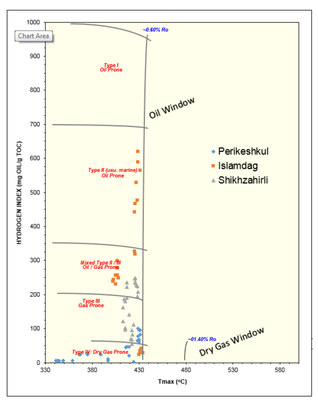
Shikhzahirli

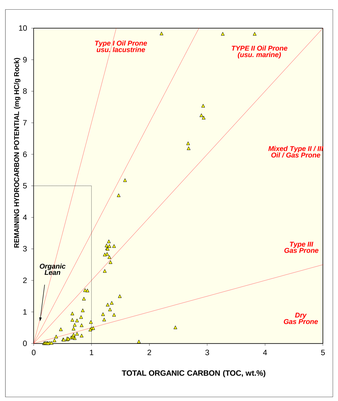




Ratios of Ur/Th and Cr/V have been shown to be reliable indicators of the oxygen conditions of the waters in which sediments were deposited (Jones & Manning, 1994). Comparison of sample suites for each sample location reveals that only one sample suite that was collected was deposited in anoxic to dysoxic water conditions: sample suite MI 9-16 from Mount Islamdag. These samples, along with MS 17-24 and MPP 1-8 have been selected for Re-Os geochronology, the data from which is still pending. These sample suites were chosen for their potential to resolve the timing of the isolation of the Paratethys Sea and to add geochronologic constraints to the stratigraphy of these well-studied outcrops.

Pyrolysis Data





Pyrolysis data reveals that the Maikop had two primary sources of organic matter: normal marine and terrestrial organic matter types. This may have an effect on the results of Re-Os geochronology because the Re-Os method depends on rhenium and osmium bound to organic matter in seawater, which is assumed to be homogenous in abundances of the radioactive isotopes. Different controls of Re & Os binding to terrestrial organic matter will have to be taken into account to reconcile any possible differences.

Conclusion

Geochemical indicators thus far indicate that samples were collected from lithologic units of the Maikop deposited both under oxic to anoxic conditions. Mixed organic matter types may be problematic to Re-Os geochronology, but at least one sample suite was deposited in anoxic to dysoxic conditions in a normal marine environment. Furthermore, Re-Os geochronology has never as yet been tested on organic-rich mudstones that are this geologically young. If these difficulties are overcome, the Re-Os geochronology will provide accurate, quantifiable stratigraphic and chronologic controls on a petroleum source rock that has as yet been notoriously difficult to constrain.