Variation of the Organic Carbon Isotope Ratio ($\delta^{13}C_{org}$) and the Total Organic Carbon (TOC) Within the Barnett Shale (Texas, USA): A signal of 2nd Order Sea Level Change in the Mississippian

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Seven wells (five in Tarrant county, one in Johnson county , one in Bosque county), covering approximately 100 km along the NNE-SSW trend of the axis of the Fort worth basin (Texas, USA), were selected for the measurement of total organic carbon (TOC) as well as organic carbon isotope ratio ($\delta^{13}C_{org}$) of the Mississippian Barnett shale. The TOC and $\delta^{13}C_{org}$value of 98 rock cuttings from 7 wells ranges from 1.3 to 6.2%, and -23.9 to -29.7‰ (means -27.4‰), respectively. If we assume $\delta^{13}C_{org}$ value of two end members i.e. marine and continental organic matter, to be -22 and -30 ‰, respectively, our study indicates the dominance of continental type organic matter within the study area of the basin. The systematic variation of TOC and $\delta^{13}C_{org}$ of each well reveals that the Barnett shale is characterized by three major cycles. Each cycle is characterized by inverse correlation between TOC and $\delta^{13}C_{org}$. The trend of decreasing or increasing continental-type organic matter (increasing or decreasing value of $\delta^{13}C_{org}$) with decreasing or increasing TOC is unusual (Creaney and Passey, 1993). The TOC and $\delta^{13}C_{org}$cycles can be correlated with the 2nd order global sea level curve. The study suggests that each sea level rise was tied with decreasing value of $\delta^{13}C_{org}$ and increasing value of TOC. The sea level rise within the basin may be due to positive water balance with an excess outflow of relatively low salinity surface water, which inhibited the haline circulation of the basin and made it more anoxic (e.g. present day Black sea). The basin anoxia condition might have resulted from basin restriction due to increased tectonic activity along the Ouachita thrust (this time was characterized by increased tectonic activity along the Ouachita thrust due to the approach of the Laurentia towards Gondwana). On the other hand, the sea level rise as a result of deglaciation due to increased P_{CO2} level, caused more input of continental type organic matter within the basin. The positive correlation between TOC and phosphate content along the depth profile from one well confirms this argument (more nutrient supply during sea level rise). Both PCO2 rise and basin anoxia together increased the preservation possibility of continental type organic matter. Therefore, the TOC and $\delta^{13}C_{org}$ cycles within the Barnett Shale were the results of complex interplay among P_{CO2}, basin anoxia and tectonic activities.