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Interactive comment on "The Depth Limit for the Formation and Occurrence of Fossil Fuel Resources" *by* Xiongqi Pang et al.

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As the conventional reservoirs have been mostly discovered and produced, the exploration work is gradually shifting to deeper, more changeling targets. This paper is aiming to provide possible vertical depth limits of potentially commercial reservoirs in a basin, and therefore lower the exploration risks. This study utilizes a large quantity of geochemistry and reservoir property data collected from 6 major, oil- and gas-producing basins in China as well as other major petroliferous basins around the world. The idea is the hydrocarbon generation and expulsion history of source rocks play a crucial role in the distribution of oil and gas reservoirs in a sedimentary basin. A variety of source rocks, including the Cambrian – Ordovician carbonate, Permian to Triassic marine shales, Carboniferous – Permian coals, and Paleogene lacustrine shales

are included in the study and these source rocks have remarkably different TOCs and thermal maturities. It's quite clear that this paper shows an objective of significant importance to the oil industry and lays a robust foundation in terms of dataset. This paper uses the hydrocarbon generation potential index ("S1+S2"/TOC) as the key method to determine the ASDLs. This method was proposed more than 10 years ago and has been successfully applied in a number of petroliferous basins in China (including those 6 basins in this study). From numerous previous studies, the changes of the hydrocarbon generation index with thermal maturity (Ro) or depth can be used to simulate the amount of hydrocarbon generated and expelled from source rocks in the geologic history. In the meantime, the maximum depth or thermal maturity can also be determined when the hydrocarbon potential approaches to zero. The results from this method are very consistent with those ASDLs determined from other geochemical parameters as well as the exploration results. In my opinion, there are two things need be cleared. First, how to determine the trends of the envelope lines indicating the change of the hydrocarbon potential index with depth or thermal maturity. Numerous studies have been done and published using this method in a number of basins in China. Detailed work has been conducted on source rocks with different kerogen types. The hydrocarbon generation potential indexes of these different types of source rocks all displayed similar trends (kind of like bell-shape) with depth or thermal maturity. But different source rocks showed very different hydrocarbon expulsion thresholds and efficiencies. These varying scenarios have been built on actual geochemical data and subsequently modeled by computer. Therefore, the envelop lines in this study are not randomly drawn but are guided by those well-established models. This has to been clearly explained because it is critical for the determination of the ASDLs. Second, this study proposes a linear equation to predict ASDL using basin heat flow data. It looks pretty good with the data from the 6 basins in the study, but there are only 6 data points. Statistically, the prediction is not be that robust. Two other things may also cause inaccurate predictions using this equation. First, basin heat flow (HF) can vary significantly over the geologic history. This paper did not clearly state the heat flow is the paleo-HF or

present HF of the basins. Second, I assume the depth is the present-day burial depth, which can be very different from the maximum burial depth in the basin history, especially foreland basins (e.g. Appalachian Basin, USA). The late-stage uplifting in the Appalachian Basin can be up to thousands of meters. Marcellus Shale in the northeast Pennsylvania, for example, shows very high thermal maturity (3 – 4.5% Ro) and in some area, has passed the ASDL, but the present-day depth generally is less than 3 – 4 km. In contrast, some rifted basins have never undergone any uplifting at all. Given the complex geologic histories of some basins, thermal maturity (Ro) appears to be more reliable (also pointed out in this paper). Although different types of basins are included in the study and the predicted ASDLs appear to be very reasonable, it would be nice to run some blind test including some data from basins in other continents. Also, it would be great to add some assumptions regarding the possible limitations of this application. In summary, this paper has a well-defined objective, a huge amount of data, a well proved methodology, and very solid results. The publication of this paper will bring a remarkable impact to the oil industry and the new findings from this paper surely will help lower exploration risks.

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