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USGS assessments of unconventional gas and oil resources in China

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The potential for unconventional (continuous) gas and oil in China is strongly influenced by its tectonic history. Paleozoic rocks beneath some long-lived Chinese basins (for example, Sichuan and Tarim Basins) include shales rich in Type II organic matter that accumulated in deep marine environments and contain viable shale gas resources. In late Paleozoic to Triassic time, essentially all Chinese basins lost their open marine character (a situation that persists up to the present), with predominantly nonmarine to marginal-marine lithofacies as a result of tectonic convergence, suturing of cratonic blocks and uplift as Asia was assembled. Such lithofacies were conducive to development of basin-centered tight gas and coalbed methane accumulations, exemplified by gas fields in the Ordos Basin and analogous to several late Paleozoic and Mesozoic basins in the central and western interior of the United States. Some lacustrine shales and carbonates, rich in Type I organic matter (i.e., Late Permian of the Junggar Basin, and possibly parts of the Tertiary section in the Bohaiwan Basin) could represent an important lacustrine shale oil or tight oil resource, analogous to the mature parts of the Eocene Green River Formation in the western U.S. All Chinese basins contain a strong Mesozoic and Cenozoic tectonic overprint that increases the risk of hydrocarbon leakage.

The U.S. Geological Survey (USGS) is quantitatively assessing undiscovered unconventional oil and gas in key Chinese basins as part of a larger effort to assess unconventional resources in priority basins worldwide. In the past year, we have completed geologic-based assessments of shale gas resources in the Sichuan Basin, and both tight and coalbed gas resources in the Ordos Basin. Future USGS assessments of unconventional oil and gas might include plays in the Junggar, Tarim and Bohaiwan Basins.

In the Sichuan Basin [1], we estimated a mean 23.9 trillion cubic feet (TCF) of technically recoverable shale gas resources in Paleozoic strata, with a range from 4.5 to 58.4 TCF (F95-F5 probability). Six assessment units (AUs) were quantitatively assessed: Cambrian Qiongzhusi Platform and Foldbelt AUs (estimated to contribute 22 percent to the mean estimated resource), Silurian Longmaxi Platform and

Foldbelt AUs (including uppermost Ordovician Wufeng Formation) (68 percent), and Permian Longtan Platform and Foldbelt AUs (10 percent). These AUs contain organic-rich shales that are the principal source rocks for conventional oil and gas in the Sichuan Basin. Since 2008, there have been multiple tests of gas potential in Cambrian, uppermost Ordovician, and lower Silurian shales in the Sichuan Basin. Commercial production of shale gas from the Longmaxi Formation in the southeastern foldbelt began in late 2012.

In the Ordos Basin [2], we estimated mean technically recoverable resources of 28 TCF of tight gas (with a range of 13.2 to 50.0 TCF) and 5.6 TCF of coalbed gas (with a range of 2.3 to 11.3 TCF) in upper Paleozoic rocks from which large volumes of tight gas and coalbed gas have already been produced. The Upper Paleozoic Tight Gas AU covers the central part of the basin including the supergiant Sulige gas field. Sources of the gas are the coal beds in the upper Carboniferous Taiyuan and lower Permian Shanxi Formations. Reservoirs are mainly low-permeability sandstones, especially in the Shanxi and middle to upper Permian Shihezi Formations. The accumulation is a basin-centered gas-charged zone with an updip water leg. Future potential is envisioned as extending into lithofacies with lower porosity and permeability than what is being currently developed. The Upper Paleozoic Coalbed Gas AU is confined to the eastern flank of the basin; in this AU, the coals in the Taiyuan and Shanxi Formations are both the source of the gas and the reservoir.

References:

[1] Potter et al., USGS Fact Sheet 2015-3053 https://pubs.er.usgs.gov/publication/fs20153053

[2) Charpentier et al., USGS Fact Sheet 2015-3987 https://pubs.er.usgs.gov/publication/fs20153087