

Assessing Composite Storage Formations for Geologic Carbon Sequestration

Marc L. Buursink, Ernie R. Slucher, Matthew D. Merrill, Peter D. Warwick

U.S. Geological Survey, 12201 Sunrise Valley Drive, Reston, VA 20192

As part of the U.S. Geological Survey domestic geologic carbon dioxide (CO₂) sequestration assessment we have identified composite storage formations in several basins. A composite storage formation or assessment unit (SAU) consists of multiple reservoir rock intervals and a single regional seal. In contrast, a typical SAU consists of a single reservoir formation and regional seal pair. If multiple reservoir rock units are deposited without an intervening thick regionally distributed seal, these formations may be assessed as one composite SAU, and the total gross thickness of all the reservoir rock is included. Initially, the net thickness, average porosity, and permeability distribution are expressed separately for each formation in the composite SAU. Available literature may provide isopach maps and reservoir properties (from core samples or pumping tests) for distinct facies in the formations. A GIS workflow is applied to sum the net porous thickness.

To illustrate the concept of composite SAU's we provide two examples from assessment work in Wyoming. The first composite SAU spans the Paleozoic formations in the Southwest Wyoming Province (SWWP or Greater Green River Basin). The reservoir formations include the Pennsylvanian Tensleep Sandstone and the Weber Sandstone, the Mississippian Darwin Sandstone Member of Amsden Formation and the Madison Limestone, and the Ordovician Bighorn Dolomite. The assessed regional seal is the Permian Phosphoria Formation, which is about 100 ft. thick in this basin with shale and anhydrite. For example, the Tensleep is white ledge-forming sandstone with an average gross thickness of 600 ft. The Madison is mostly carbonate rocks with an average thickness of 250 ft. The Bighorn is massive or thin-bedded dolomite, with a sandstone member, and exhibits 450 ft. gross average thickness. Due to porosity and lithology variations, the assessed net porous interval for each formation is a fraction of its gross thickness. The Cambrian Flathead Sandstone was not included, for example, due to its low net-to-gross porous interval and intervening shales. By assessing multiple formations in the SWWP, we increase the net porous thickness of a nearly five-million acre SAU. We do not find that the net thickness of the composite SAU exceeds our predicted maximum column height for CO₂ (about 2,500 ft.). A similar composite SAU consisting of Paleozoic formations was assessed in the Wyoming Thrust Belt (WTB). Though it is smaller, at slightly over three-million acres due to multiple thrust faults, the gross SAU thickness is greater because of repeated sections. For example, the Madison is about 1,300 ft. thick here due to over-thrusting. Only areas where the Phosphoria Formation (with an average thickness of 400 ft.) is present, as a regional seal, are included in the composite SAU. Our separate net-to-gross estimates for the formations in the SWWP are applied to the correlative WTB rocks.