1. Abstract

1.1 Overview

Carbonate caprocks associated with salt diapirs and salt walls have long been considered important targets for oil and gas exploration due to their propensity to trap oil, gas, and water. Despite advances in the understanding of salt wall and caprock dynamics, essential information regarding the genesis and alteration of the carbonate minerals that constitute caprocks is missing. This is particularly true regarding the involvement of microorganisms in the precipitation of caprock carbonate minerals and in regard to the timing of the genesis of individual carbonate phases and their chemical and physical properties. This lack of knowledge negatively impacts oil and gas exploration since properties such as porosity and permeability are decisive for the potential of caprocks to act as hydrocarbon reservoirs.

1.2 Intellectual Merit

The objective of this study is to test the hypothesis that sulfate reducing and sulfur oxidizing microbes mediate calcite and dolomite formation in caprocks. A salt wall in Gypsum Valley, which is located in the Paradox Basin, Southern Colorado, displays exceptionally well-exposed outcrops of gypsum overlain by carbonate caprocks. The caprocks are often brecciated, contain dolomitic and calcitic clasts, and are of an enormous variety ranging from dark petroliferous carbonates to siliceous reddish and yellowish carbonates. The outcrop conditions and the variety of carbonate rocks in the study area provide an outstanding opportunity to test the hypothesis of this study. Methods employed will include: Field mapping and thin section analysis will allow unambiguous mineral phases identification (i.e. calcite, dolomite) and determine carbonate mineralization stages from the geometry between different caprock components. Concentration and isotope analysis of different sulfur phases such as carbonate associated sulfate, pyrite and organically bound sulfur, coupled with the analysis of the carbon and oxygen isotope composition of the carbonates of selected samples will then reveal if different carbonate mineralization stages are associated with specific microbially catalyzed reductive or oxidative sulfur transformations.

1.3 Broader Impacts - Contributions within Discipline

On a local to regional scale, this study will improve the understanding of the geology of the Paradox Basin, where carbonate rocks found in contact with salt domes were previously considered to have formed subsequently or contemporaneously to evaporite deposition or as sediments deposited during subaerial exposure of evaporites (e.g. as paleosols). The obtained geochemical data will provide criteria for the re-assignment of these carbonates as caprocks. This study will further answer if microbes were intimately involved in the formation of dolomitic caprocks, which would have far reaching consequences. For basic research, it means that microbial dolomite formation is not just an isolated process tied to rather exotic environments (e.g. hyper-saline lagoons or the deep biosphere), but that it can also constitute massive sedimentary deposits. For oil exploration, it could indicate that the presumption that dolomite in caprocks is of secondary origin, and as such, typically porous (i.e. an excellent reservoir rock), is not correct. This would call for a differentiated view on dolomites as potential reservoir rocks.