Abstract

The Jurassic Morrison Formation, composed of two members - the Salt Wash and Brushy Basin - can be found surrounding and partially burying the Gypsum Valley diapir in the Paradox Basin, Colorado. The diapir began passively rising during the Late Pennsylvanian/Early Permian and continued to rise differentially along the length of the salt wall until the Late Jurassic, when the Morrison Formation was deposited. The diapir was breached during Neogene erosion of the Colorado Plateau, exposing the diapir caprock. Folds within the Morrison Formation are preserved along the diapir margins where the Morrison overlies the salt. These are best exposed at the southeastern part of Big Gypsum Valley as a series of tight folds that get progressively more open to the northwest. A detailed map along the diapir margin shows synclines and subhorizontal Morrison beds in direct contact with the salt. The lower beds of the Morrison onlap the tilted strata flanking the diapir, indicating continued minibasin subsidence and diapir rise that continued into Salt Wash time. Basal strata of the Morrison contains clasts of diapir and other flanking strata reflecting erosion of the diapir margin by the first channels that flowed across the diapir. These included 1 cm long, ½ cm thick green-gray clay chips and Paradox Formation limestone clasts that can be observed at the base of Morrison sandstone channels ranging in thickness from 0.5 m - 2 m.

Measured sections have been completed on both the northeastern and southwestern part of Big Gypsum Valley. These, along with the tracing of beds along the diapir margin, better displayed a change in bed thickness, which thinned into the axes of synclines and thinned on anticlines. Thus indicating the folds in the Morrison were syndepositional and associated with diapir subsidence or movement during early Morrison deposition. The initial results of this study indicate that diapir and salt movement continued through at least Basal Salt Wash time. The lack of faulting in some areas indicates that much of the Morrison is in place and has not been dropped into its present location through diapir dissolution collapse. Faulting and rotation of the Morrison in other areas indicates that solution collapse may have been locally important. Constraining the mechanisms that formed these structures will help improve our understanding on how salt diapirs function and their impact on the surrounding strata, which could ultimately serve as traps for resources such as oil and gas.
The Jurassic Morrison Formation, composed of two members - the Salt Wash and Brushy Basin - can be found surrounding and partially burying the Gypsum Valley diapir in the Paradox Basin, Colorado. The diapir began passively rising during the Late Pennsylvanian/Early Permian and continued to rise differentially along the length of the salt wall until the late Jurassic, when the Morrison Formation was deposited. The diapir was breached during Neogene erosion of the Colorado Plateau, exposing the diapir caprock. Folds within the Morrison Formation are preserved along the diapir margins where the Morrison overlies the salt. These are best exposed at the southeastern part of Big Gypsum Valley as a series of tight folds that get progressively more open to the northwest.

A detailed map along the diapir margin shows synclines and subhorizontal Morrison beds in direct contact with the salt. The lower beds of the Morrison onset on the tilted strata flanking the diapir, indicating continued minibasin subsidence and diapir rise that continued into Salt Wash time. Basal strata of the Morrison contains clasts of diapir and other flanking strata reflecting erosion of the diapir margins by the first channels that flowed across the diapir. These included 1 cm long, ½ cm thick green-gray clay chips and Paradox Formation limestone clasts that can be observed at the base of Morrison sandstone channels ranging in thickness from 0.5 m - 2 m. Measured sections have been completed on both the northeastern and southwestern part of Big Gypsum Valley. These, along with the tracing of beds along the diapir margin, better displayed a change in bed thickness, which thinned into the axes of synclines and thinned on anticlines. Thus indicating the folds in the Morrison were synsedimentary and associated with diapir subsidence or movement during early Morrison deposition. The initial results of this study indicate that diapir and salt movement continued through at least Basal Salt wash time. The lack of faulting in some areas indicates that much of the Morrison is in place and has not been dropped into its present location through diapir dissolution collapse. Faulting and rotation of the Morrison in other areas indicates that solution collapse may have been locally important. Constraining the mechanisms that formed these structures will help improve our understanding on how salt diapirs function and their impact on the surrounding strata, which could ultimately serve as traps for resources such as oil and gas.

The findings will also contribute to creating models that try to define the resulting stratigraphy when salt is the main driver of sedimentation patterns.

To document the geometries and distribution of the folds found within the Morrison Formation, which run parallel to the diapir margins. Define the mechanisms that formed these folds in order to improve our knowledge on how salt diapirs function and their impact on the surrounding strata.

The study area is located in the southernmost part of Gypsum Valley, one of the salt structures found within the Paradox Basin (Figs. 1, 2). The Paradox Basin;

- Formed during the Ancestral Rocky Mountains orogeny
- Is flanked on the northeast by the Uncompahgre uplift and on the southeast by the Four Corners platform (Fig. 1a)
- Salt was deposited during the Pennsylvanian in the Paradox Formation
- It was during the mid-Jurassic that cessation of diapirism is thought to have occurred and the Morrison Formation was deposited (Fig. 3).

The Paradox Basin is divided into:

- Inboard margin
- Outboard margin
- Salt shoulders

Salt behaves in a ductile fashion when responding to regional tectonic stresses and differential loading.

Salt shoulders - low angle segments of the salt-sediment interface where the margin of a passive diapir steps abruptly inboard

Divided into:

- Inboard margin
- Outboard margin

In the southern end of Big Gypsum Valley, the Morrison Formation forms a salt shoulder that wraps around the southeastern end of the diapir.

Figure 5 shows the formation of a salt shoulder and the resulting stratigraphic geometries.
The Morrison Formation

- In this study, our focus is on the Jurassic Morrison Formation. The primary members in the region include the upper Horizon, Brushy Basin, and Salt Wash Members (Figure 6).

- The Salt Wash member can be broken up into four separate units (Figure 7).

- The colors shown in the figure above represent the different channels found in the Paleo Canyon to the SW of the salt diapir, where the dark line is the canyon margin.

- The Morrison Formation incises at least 4 m into the underlying strata, which could potentially breach traps.

- Stratigraphic sections show that 89% of the canyon is composed of sands and 11% is shales. Because the shales are not laterally consistent, there is no effective seal in the canyon.

- Stratigraphic sections vary in thickness from 10 m (on the anticline axis) to 21 m.

- Stratigraphic units thicken outwards from the anticline's axis with a lateral change of 3 m.

- The stratigraphic units thin onto the anticline and thicken into the syncline (

- 96% lateral increase in thickness.

- The stratigraphic units increase in thickness from 10 m (anticline axis) to a maximum of 33 m (syncline axis).

- The stratigraphic units can thicken and form channels in the salt diapir.

- In the region, channels and fill features are common, indicating a change in flow direction parallel to the fold axes (SE).

- The flow direction is parallel to the fold axes (SE), possibly indicating a structural influence on the channels.

- The stratigraphic sections measured in area A show a series of folds within the Morrison Formation and are divided into two areas: B.1 and B.2.

- The stratigraphic sections measured in area B show a series of folds within the Morrison Formation and are divided into areas B.1 and B.2.

- The stratigraphic sections measured in area C are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area D are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area E are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area F are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area G are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area H are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area I are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area J are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area K are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area L are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area M are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area N are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area O are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area P are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area Q are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area R are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area S are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area T are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area U are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area V are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area W are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area X are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area Y are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area Z are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area AA are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area BB are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area CC are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area DD are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area EE are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area FF are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area GG are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area HH are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area II are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area JJ are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area KK are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area LL are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area MM are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area NN are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area OO are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area PP are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area QQ are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area RR are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area SS are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area TT are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area UU are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area VV are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area WW are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area XX are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area YY are anticline/syncline couples at area B.1 and B.2.

- The stratigraphic sections measured in area ZZ are anticline/syncline couples at area B.1 and B.2.
Results

The lower beds of the Morrison Formation onlap the tilted strata flanking the diapir.  
- Indicating continued minibasin subsidence and diapir rise as the Morrison Formation was being deposited.

Basal strata of the Morrison Formation contain diapir-derived detritus, such as green-clay chips and carbonate pebbles.  
- Reflecting erosion of the diapir margin by the first channels that flowed across the diapir  
- Indicate that the Morrison Formation was deposited directly on top of the diapir rather than faulted against it  

There is a lateral change in bed thickness within the Morrison Formation, which thins on anticlines and thickens on synclines. The basal units pinch out against the salt diapir.  
- Suggests that the Morrison Formation was being folded as it was being deposited.

On the SE side of the salt diapir, the Morrison Formation incises into the salt diapir and older units of the megaflap to create a Paleo Canyon.  
- Shows that the contact between the Morrison Formation and the underlying units isn’t a horizontal surface.

Conclusions

The initial results of this study indicate that diapir and salt movement continued through at least Salt Wash time in the late Jurassic.

The lack of faulting in some areas indicates that much of the Morrison Formation is in place and has not been dropped into its present location through diapir dissolution collapse as has been previously thought.

Bedding shortening through folding is evident in the Morrison Formation, which could be the result of salt movement during deposition.

Diapir-derived clasts found within the basal units of the Morrison Formation further imply that the it was in direct contact with the salt diapir during deposition.

The pinching out of basal units against the salt diapir indicate that the Morrison Formation was being folded during deposition, thus making the deformation syndepositional.

Possible Reservoir and Trap Locations

The schematic to the left shows four sites that are possible outcrop analogues of reservoirs and traps.  
- The crests of anticlines on units deposited on the salt  
- Horn traps  
- Pinch out traps  
- Stratigraphic traps where there is an unconformity between the Morrison and the older Wingate Formation

References


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