Burial wedges—Evidence for prolonged progressive burial of the Paradox Basin salt walls—With a detailed example from Gypsum Valley, Colorado

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Abstract
Many Paradox Basin passive salt diapirs underwent a prolonged history (>65 my) of progressive burial during the Early Triassic to Jurassic. Burial is recorded by a series of geographically limited wedge-shaped stratal panels of diapiric roof, termed ‘burial wedges’, which partly covered the diapirs, thereby gradually narrowing them. Tectonostratigraphic analysis of the Triassic Chinle Fm. burial wedge developed on the Gypsum Valley diapir illustrates the typical features and processes associated with burial wedges. Burial wedges represent the first description of the geometry and deposition of strata deposited on a partially buried diapir. Recognition of burial wedges allows reinterpretation of Paradox Basin diapirs where large areas of the roof strata were syndepositionally folded rather than deformed in the Neogene. The observations and concepts can also be applied to the terminal histories of passive salt diapirs in other salt basins. Preserved burial wedges cover 97 km², or 64% of the original Gypsum Valley diapir and overlie regional unconformities. Onlapping strata stack into wedge halokinetic sequences (HS). Caprock-clast conglomerates indicate deposition on exposed diapirs. Syndepositional deformation of burial wedge strata formed small synclinal ‘microbasins’ and contractional chevron folds trending subparallel to the diapir margin. A four-stage burial wedge model includes the following: (1) erosion of the diapir roof during formation of regional unconformities; (2) onlap and partial burial of the diapir; (3) local dissolution and possible concomitant gravity-driven folding and (4) ongoing rotation during deposition, forming wedge HS signifying continued inflation of the top of the diapir. Post formation, the burial wedges were deformed in ways that obscure their original geometry. The most common deformation is downwarping of the burial wedge into the diapir due to dissolution or lateral movement of salt, creating an anticlinal fold that overlies the...
1 | INTRODUCTION

Salt tectonic studies of passive diapirs have historically focused on the depositional and structural processes involved in diapir initiation and the subsequent passive rise and attendant salt-sediment interaction (Alsop et al., 2016; Gannaway Dalton et al., 2020; Matthews et al., 2007; Rowan et al., 2003; Stewart, 2006). In contrast, little attention has been paid to the depositional and deformational styles and processes present as passive diapirism ends and burial ensues, even though these terminal diapir roof zones can provide significant hydrocarbon traps (Halbouty, 1969) as well as important constraints on halokinesis during the waning stages of diapirism. Moreover, understanding of the geometries and processes of final burial can be extrapolated to strata deposited in times of rapid sedimentation, and consequent temporary burial, during ongoing passive diapirism, that is, to upturned flaps in tapered composite HS (CHS) (Giles & Rowan, 2012) that form the updip parts of three-way truncation traps against diapirs.

Our ongoing stratigraphic and structural analysis of the terminal roof strata of five exposed salt walls in the Paradox Basin of Utah and Colorado indicates that cessation of passive rise and complete burial was preceded by a >65-million-year-long, stepwise process of abrupt and episodic narrowing of the diapirs. Partial diapir burial events formed geographically limited, wedge-shaped panels of terminal diapir roof strata, here termed ‘burial wedges’ (Figure 1). Burial wedges extend from the previous diapir margin (outboard margin) to an inboard margin where the remaining, narrower diapir continued to passively rise, creating topographic relief and attendant halokinetic drape folding (Figure 1). Formerly, these features were conceived as post-diapirc, fault-bounded, roof collapse blocks extending into the diapir (Ge et al., 1996). We demonstrate here that the exposed strata were deposited on diapiric salt as burial wedges and subsequently folded into the diapir, rather than faulted. We originally had termed these salt shoulders, and used this term in several publications (e.g. Giles et al., 2018). However, the term salt shoulder describes the salt geometry and should be confined to locations where steep diapir rise continues in a more inboard position. It is the strata immediately above the salt that form burial wedges, which may cover only a shoulder or the entire width of diapir that is ceasing passive rise.

Burial wedges record the depositional, and subsequent deformational processes active on the roofs of salt diapirs during the waning stages of local diapirism, and show that these processes, which can affect the geometry and continuity of hydrocarbon traps, continue as salt domes are progressively covered. Burial wedges demonstrate that diapir roof deformation is clearly distributed, with greater rise in the centre, and less on the margins. Burial wedges are previously unrecognized stratigraphic features in salt basins, but are likely relatively common once you start looking for them.

This study provides the first outcrop descriptions of salt-sediment interaction on passive diapirs during progressive burial. We use the Triassic Chinle burial wedge at Gypsum Valley salt wall to illustrate the key structural and underlying diapir margin. These anticlines may be offset on small normal faults subparallel to the diapir margin. Burial wedges were faulted during later diapir breaching and solution collapse.

**KEYWORDS**
diapir burial, folding, halokinetic sequences, microbasins, Paradox Basin, salt diapirs, salt walls

**Highlights**

- Burial of salt domes can coincide with continued deformation of roof strata forming halokinetic sequences in burial wedges that onlap portions of diapirs.
- Individual diapirs in the Paradox Basin were buried episodically over periods that lasted 65 million years.
- Microbasins are local synclines that form syndepositionally on burial wedges.
- Syndepositional folds formed in the bases of some burial wedges and probably reflect gravity driven deformation due to topographically high exposed diapirs.
- Potential reservoir facies may be localized in burial wedges.
- Stratigraphy and clast lithologies indicate repeated erosion of adjacent caprock during burial wedge formation.
stratigraphic features associated with burial wedges as it is the best exposed and has been studied in the greatest detail. We include here a detailed description and interpretation of it, to illustrate the attributes of Paradox Basin burial wedges and to identify the processes that continued episodically to form a series of geographically limited burial wedges over Gypsum Valley diapir from the Triassic through the Jurassic. Additional data that supports the findings of this study are available in the Supplementary Material of this article.

2 | GEOLOGIC SETTING

2.1 | Paradox Basin

The Paradox Basin contains 13 elongate salt diapirs, 8 of which have been breached during Neogene erosion, exposing the diapirs and flanking strata (Baars & Stevenson, 1981; Cater, 1970; Doelling, 1988; Hite et al., 1972; Joesting & Byerly, 1958; Jones, 1959; Shoemaker et al., 1958). The diapirs are northwest–southeast trending salt walls from 1- to 5-km wide and up to 40-km long (Figure 2). The salt walls are separated by 8- to 15-km wide and up to 40-km long minibasins formed by salt evacuation and salt flow into the flanking salt diapirs.

The Paradox Basin formed in the Early Pennsylvanian (Atokan) and is interpreted as a foreland basin bounded to the northeast by high-angle thrusts that produced the Uncompahgre uplift (Baars & Stevenson, 1981; Barbeau, 2003; Kluth & Duchene, 2009; Trudgill & Paz, 2009; White & Jacobson, 1983) (Figure 2). Paradox Formation layered evaporites represent the initial fill in the basin (Hite & Gere, 1958; Peterson & Hite, 1969). Diapirism began in the Late Pennsylvanian or Early Permian due to rapid sediment loading by fluvial sediments of the Cutler Group (Ge & Jackson, 1998; Trudgill, 2011; Trudgill & Paz, 2009) (Figure 3). Diapirism ceased during the Early Jurassic in the northern Paradox Basin (Doelling, 1988; Trudgill, 2011), but continued until the latest Jurassic in the southern part of the basin (Doelling, 1988; Ge & Jackson, 1998; Hite et al., 1972; Shoemaker et al., 1958). The diapirs were buried under a kilometre of sediment in the Late Cretaceous (Baars & Stevenson, 1981; Doelling, 1988; Nuccio & Condon, 1996; Stevenson & Baars, 1985; Trudgill, 2011; Trudgill & Paz, 2009). Neogene erosion exposed the diapirs as the rising Colorado Plateau was incised (Baars & Stevenson, 1981; Doelling, 1988; Nuccio & Condon, 1996; Trudgill, 2011; Trudgill & Paz, 2009).

The Paradox Formation layered evaporites were 2 to 2.6 km thick initially (Hite & Buckner, 1981; Rasmussen & Rasmussen, 2009) and consist of cyclically interbedded evaporites, dolomite, and organic-rich mudstones (Hite & Gere, 1981; Hite & Gere, 1958; Peterson & Hite, 1969; Trudgill & Arbuckle, 2009). The overlying Honaker Trail Formation comprises approximately
350 m of interbedded siliciclastics and carbonates (Ritter et al., 2002; Wengerd, 1963; Wengerd & Matheny, 1958; Williams, 1996) (Figure 3). The Paradox Basin was filled and most passive diapirism occurred during the Early Permian deposition of the overlying arkosic conglomerates, sandstones and shales of the Cutler Group (Dubiel et al., 2009; Rasmussen & Rasmussen, 2009; Trudgill, 2011). The overlying Triassic Moenkopi Formation consists of marginal marine thin bedded, dark brown sandstones and shales (Blakey, 1973; Shoemaker & Newman, 1959; Stewart et al., 1972).

The Chinle Formation overlies the regional mid-Triassic (Tr-3) unconformity (Figure 3), consists of fluvial, red feldspathic sandstones and shales, and ranges up to 190 m in thickness (Cater, 1968; Stokes & Phoenix, 1948). The J-0 unconformity separates the Chinle from the Upper Triassic-Lower Jurassic Glen Canyon Group (Blakey, 1989; Doelling, 1988; Pipiringos & O’Sullivan, 1978; Stewart, 1969). The Glen Canyon Group consists of the basal aeolian, Wingate Sandstone, overlain by the fluvial Kayenta Formation followed by the aeolian Navajo Sandstone (Blakey, 1989; Pipiringos & O’Sullivan, 1978;
The regional J-2 unconformity separates the Glen Canyon Group from the overlying Upper Jurassic San Rafael Group, which consists of the aeolian Entrada Sandstone and shallow marine Summerville Formation separated by the J-3 unconformity (Gilluly & Reeside, 1928; Lucas, 2014; Pipiringos & O’Sullivan, 1978). The fluvial Morrison Formation overlies the regional J-5 unconformity and is subdivided into the Salt Wash and Brushy Basin members (Craig, 1955; Kowallis et al., 1991; Owen et al., 2015). Overlying the Morrison is the Lower Cretaceous Burro Canyon/Cedar Mountain Formation (Aubrey, 1995; Craig, 1981). Sevier foreland basin sediments of the Dakota Sandstone, Mancos Shale and Mesa Verde Group uniformly covered the Paradox Basin during the Late Cretaceous (DeCelles, 2004).

We have documented burial wedges at five of the breached diapirs in the Paradox Basin: Gypsum Valley, Paradox Valley, Moab Valley, Onion Creek and Salt Valley (Figure 2). These diapirs have been the subjects of research that includes detailed mapping and cross sections that illustrate the features we now term burial wedges (Baars & Doelling, 1987; Boyers, 2000; Cater, 1954; Doelling, 1988, 2002; Hite et al., 1972; Hudec, 1995; Naqi, 2016). We name burial wedges using the age and formation name of the strata in the burial wedge. Paradox burial wedges range in age from Permian through latest Jurassic (Table 1). We use Gypsum Valley salt wall as our example diapir for burial wedge formation as its burial wedges exhibit most of the features and geologic evolution recognized in the other burial wedges throughout the basin.

2.2 | Gypsum Valley salt wall

Gypsum Valley is the southernmost Paradox Basin salt diapir (Figure 2). It is an elongate, 40-km-long by 4.5-km-wide, breached diapir (Figure 4). Paradox caprock, in the form of gypsum, carbonate and black shale, is exposed in a broad flat valley, which is surrounded by cliffs and ridges formed of strata ranging in age from Pennsylvanian to Cretaceous (Figure 4b). The Dolores River cuts obliquely across the valley and divides it into Big Gypsum Valley (BGV) to the southeast and Little Gypsum Valley (LGV) to the northwest (Figure 4a).

BGV is characterized by a broad valley floor of exposed caprock, partially covered by a thin mantle of Quaternary alluvium (Figures 4 and 5b). Confined to the margins of BGV are large (>1000 m²) fault-bounded blocks of Upper Jurassic Morrison Formation and overlying Cretaceous strata directly overlying gyspic caprock. In contrast, LGV is floored by folded and faulted Jurassic and Cretaceous strata with smaller, limited exposures of gyspic and carbonate caprock (Figures 4 and 5a).

3 | METHODS

The geometry and stratigraphy of the Gypsum Valley burial wedges were interpreted from detailed mapping,
cross sections, and 46 measured stratigraphic sections. Key horizons were correlated between sections and were transferred to maps and photo-panoramas. Foreset dips, climbing-ripple orientations and the azimuth of trough and channel axes were used to reconstruct paleocurrent directions. Three-dimensional models of the Triassic

FIGURE 4 Maps of Gypsum Valley. (a) Map of Gypsum Valley showing: (1) The outline of the diapir before the encroachment of the Triassic and Jurassic burial wedges and (2) the extent of the Chinle, Glen Canyon Group, Entrada and Morrison burial wedges that covered parts of the diapir. Lines mark different generations of faults. (b) Geologic map of Gypsum Valley. Stratigraphy and unit symbols are shown in Figure 3. A-A' and B-B' show the lines of the cross sections in Figure 5, and the blue boxes outline maps of Figure 6.

TABLE 1 Stratigraphic intervals comprising burial wedges in the diapirs of the Paradox basin
FIGURE 5  Cross sections showing the exposed strata and projected subsurface geometry of across the burial wedges in Gypsum Valley. Line of sections is shown in Figure 4 (a and b) and Figure 6a (c). (a) Cross section through LGV, crossing the Chinle and Glen Canyon burial wedges. Note the preservation of Triassic and Jurassic strata across the diapir. The Entrada burial wedge crosses the diapir in this section but terminates out of the plane to the southeast (Figure 4a). (b) Cross section through BGV and the Morrison Formation burial wedges. Note the vertically dipping Chinle Fm. adjacent to the diapir and the rotation of Triassic and Jurassic strata below the Morrison Formation away from the diapir. (c) Composite cross section through the Chinle burial wedge north of the Dolores River Canyon. Locations of three overlapping cross sections shown in red on Figure 6a. Thicker lines are halokinetic sequence boundaries. Thin lines show projections of observed onlapping and truncated strata at halokinetic sequence boundaries. Tadpoles show projections of some measured strikes and dips shown in Figure 6a. Hachured areas show thick beds of coarse conglomerate. Pink lines show the elevations of preserved top of salt, along with distances to those outcrops.
Chinle and Morrison burial wedges were created using digital photographs and drone imagery over 1–5 km² areas.

3.1 Gypsum Valley burial wedges

Gypsum Valley exposes four burial wedges that formed over 65 million years, from the Late Triassic to the end of the Jurassic (Figure 4a). In LGV, the Triassic Chinle burial wedge, Triassic-Jurassic Glen Canyon burial wedge and the Jurassic Entrada burial wedge progressively cover the diapir. BGV has only the Jurassic Morrison burial wedge exposed, which is found in patches around the periphery.

The margin of the salt wall beneath the burial wedges is constrained by seismic and well data. On the northeast side, a thickened section of Cutler Group strata and faulted, slightly upturned Honaker Trail Formation has been penetrated by the wells of Andy’s Mesa Field (Amador et al., 2009; DuChene et al., 2009). Seismic lines across the valley have been interpreted as exhibiting a counter-regional geometry at depth, with strata nearly flat, until upturned through drape folding adjacent to the diapir (Escosa et al., 2019). On the southwest side, a megaflap of thinned Paradox, Honaker Trail and basal Cutler Group strata attains vertical dips adjacent to the diapir (Escosa et al., 2019; Rowan et al., 2015).

The oldest exposed burial wedge at Gypsum Valley is the Triassic Chinle burial wedge, which outcrops over a distance of 13 km along the north-eastern side of LGV (Figure 4a), where it directly overlies Triassic age gypsum and carbonate caprock (Poe, 2018). The inboard margin of the Chinle burial wedge is defined by erosional truncation at an angular unconformity beneath younger strata that extend farther onto the diapir, forming younger burial wedges (Figure 5a,c). The Chinle burial wedge is overlapped at the north end of the valley by the Triassic-Jurassic Glen Canyon Group burial wedge, which extends down the southwestern side of LGV for 14 km (Figures 3, 4a,b, and 5a,c). The Glen Canyon Group burial wedge contains strata of both the Wingate and Kayenta formations, but is only exposed in scattered outcrops beneath younger strata; thus, its extent and geometry are difficult to estimate. Both the Chinle and Glen Canyon Group burial wedges are overlapped by the Upper Jurassic Entrada Sandstone, which forms a burial wedge covering most of the remaining floor of LGV (Figure 4). In contrast, in BGV, the Entrada dips away from the diapir at up to 30°, and is truncated beneath an angular unconformity and onlapped by the Summerville Formation along the southern margin and progressively onlapped by the Summerville and Morrison formations along the northwest margin of BGV. Strata of the lower Salt Wash Member of the Morrison

4 THE TRIASSIC CHINLE BURIAL WEDGE

The Triassic Chinle burial wedge is best exposed where the Dolores River canyon incises through it (Figure 6d).
FIGURE 6  (a) Geologic shaded relief map of the area of exposed Chinle burial wedge. Location of figure is shown in Figure 4b. Stratigraphy and unit symbols are shown in Figure 3. Line A–A’ shows the location of the cross section in Figure 5a; blue boxes show areas of detailed maps, and magenta lines show locations of sections 1, 2 and 3 used to make composite cross section of Figure 5c. A1–A3 and S1–S2 designate the axial traces of Morrison Fm. age anticlines and synclines referenced in the text. (b) Erosional window in NE Little Gypsum Valley, exposing Wingate, Chinle, and highly deformed Triassic dolomite caprock. (c) Detail of an area that exposes the Chinle Formation, which is overlapped by the Wingate Sandstone and Entrada burial wedges. Structural relationships are illustrated in Figure 5a. (d) Detail of the Dolores River Canyon showing the outcrop areas of the halokinetic sequences. HS-1= purple, HS-2= green, HS-3= orange, HS-4= red. (e) Location shown in Figure 4b details of Maryjane Canyon area, location shown in Figure 4b. (f) Detail of Hamm Canyon area and location are shown in Figure 4b.
Here, the Wingate, Chinle, and highly deformed underlying Triassic carbonate caprock (Draper, 2020; Poe, 2018) are exposed in three dimensions. Carbonates in the caprock and equivalent clasts in the Chinle are dated to the Triassic using U/Th dating (Poe, 2018) indicating that the caprock was near the surface prior to and during Chinle burial wedge formation. The inboard margin of the Triassic Chinle burial wedge is defined by erosional truncation beneath the Wingate Sandstone at an angular unconformity of up to 7° (Figures 5a, c and 6a, d). The outboard margin is largely buried, but is defined by an angular unconformity of 50° with the underlying Permian Cutler Formation, exposed at Hamm Canyon farther to the SE (Figure 6f). Both angular unconformities and Chinle stratal pinch-outs represent erosional truncation at HS boundaries coincident with the Tr-3 and J-0 regional unconformities (Figure 3). HS are local angular unconformity-bound stratal packages of the diapir roof that typically end up flanking passive salt diapirs due to drape folding (Giles & Lawton, 2002; Giles & Rowan, 2012; Rowan et al., 2003). The total exposed width of the Chinle burial wedge is just over 1 km. Based on the changes in dip and thickness of the Chinle Formation, we expect that this is a good approximation of the total burial wedge width (Figures 5a, c).

The Chinle burial wedge forms the southwestern limb of an asymmetric, NW–SE trending, open anticline that extends along the northern margin of LGV (Figures 4 and 6). The 25° dipping north-eastern limb coincides with the southwestern flank of the Dry Creek synclinal minibasin, and the axial trace of the anticline marks the edge of the underlying diapir (Figures 5 and 6). The Chinle Formation on the southwestern limb dips at 10° towards the interior of the diapir (Figures 5a, c and 6a, d).

4.1 | Restored geometry

Post-depositional folding and faulting make visualization of the original geometry of the Chinle burial wedge difficult. Therefore restorations were performed (Figure 7a–e) using the StructureSolver software package. Restoration of the cross sections reveals the wedge shapes were produced by differential diapiric rise across the burial wedge. It also illustrates the stepwise formation of burial wedges, which form in different places at different times. The differences between the cross sections show how diapirism continued in BGV during and after burial wedges formed in LGV.

The Chinle Formation forms a depositional wedge that tapers towards the diapir over 1 km in LGV (Figures 5 and 7a–e). Erosional truncation beneath the J-0 unconformity and internal halokinetic-sequence angular unconformities thin the Chinle from 156 m to a pinch out against the salt wall. The restorations illustrate that there was no steep rise of an inner part of the diapir, so that the Chinle burial wedge did not form above a salt shoulder (Figure 7c, d). This thinning continues along-strike to the southeast to where the burial wedge is eroded off the diapir in BGV (Figure 4a). The exposed thickness on the outboard margin of the burial wedge is a nearly complete section of the Chinle as it only thickens to 180 m in the subsurface to the northeast in the Dry Creek minibasin. (See Supplement for wells and tops data used in this manuscript).

4.2 | The basal unconformity

The Chinle strata in the burial wedge onlap the Mid-Triassic Tr-3 unconformity, which is an erosional surface with preserved rugosity of up to 1 m in a few locations. Diapiric caprock is exposed beneath the Tr-3 unconformity in the Gypsum Valley diapir (Labrado, 2021; Lerer, 2017; Poe, 2018). Caprock includes highly deformed gypsum, dolomite and limestone layers that, in some localities, parallel Chinle strata dips (Draper, 2020). Dolomite and limestone caprock clasts are found within Chinle burial wedge strata, documenting a formation prior to burial wedge formation (Heness, 2016; Labrado, 2021).

4.3 | Microbasins

The Chinle Formation in the burial wedge was locally deposited in small, oval, open synclinal basins that rest directly on diapir caprock (Figure 8). These basins are less than 2 km² and, therefore, we term them ‘microbasins’ to distinguish them from the much larger minibasins. Microbasins are elongate, roughly 250 m across and <1000 m long, and are oriented parallel to the trend of the outboard diapir/burial wedge margin (Figure 8). Growth strata in the Chinle Formation thin and pinch out against the synclinal flanks of the microbasins (Figure 9).

Deformation occurs within the underlying diapir caprock, which comprises gypsum and carbonates, and seems to precede or coincide with initial deposition of the burial wedge (Lerer, 2017; Poe, 2018). Deformation was slow and progressive and continued well into burial wedge deposition. The entire thickness of Chinle Formation is folded in the microbasins, as is the basal 15 m of the overlying Wingate Sandstone (Figure 10). There is no faulting associated with microbasin formation. The caprock exhibits a few dissolution fabrics and infiltration of modern or Mesozoic sediments. The caprock beneath the burial wedges exhibits patches of dolomite and gypsum rubble that may represent debris flows or solution breccias formed during subaerial exposure and erosion at the unconformities. However, only two areas beneath the Chinle
unconformity exhibit block rotation and brecciation, and infiltration of red Chinle sediments in these areas is limited to 1.5 m below undeformed Chinle strata (Draper, 2020).

4.4 Halokinetic sequence stratigraphy and development

The Chinle burial wedge comprises four wedge HS. Each sequence is separated from overlying strata by an angular unconformity (halokinetic sequence boundary, HSB) with a maximum truncation angle ranging from 2° to 10° (Figure 5c). Thinning within each sequence occurs through onlap onto the underlying unconformity, internal bed thinning and pinch-out and truncation beneath the overlying HSB.

Each HS forms a generally upward-fining package of fluvial facies (Heness et al., 2017; McFarland, 2016). The oldest, HS-1, is only exposed in the Dolores River canyon (Figures 6d and 10). Strata comprise mostly coarse-grained channel sandstones containing abundant pebbles...
and cobbles of diapir caprock-derived carbonate clasts (Labrado, 2021; McFarland, 2016; Poe, 2018). The angular unconformity between HS-1 and HS-2 is 2°.

HS-2 is similar in geometry and component facies to HS-1 but extends farther onto the diapir. The stratigraphy of HS-2, near its pinch-out, is similar to that of HS-1. However, the thick conglomeratic channel sandstones that predominate near its pinch-out interact with floodplain mudstones between 300 and 350 m outboard (Figure 10). Overlying HS-2 is an angular unconformity of 4° to 10° beneath HS-3. Crudely bedded matrix- and clast-supported conglomerates containing clasts of diapir-derived detritus are in angular unconformity with the overlying HS-3 strata (Figures 5c and 10). These are interpreted as remnants of debris flows deposited with or after HS-2 and partially eroded prior to HS-3 deposition.

HS-3 is the most widely and continuously exposed sequence and extends along the entire 13 km length of the burial wedge. The stratigraphy within HS-3 is similar to that of HS-2, but the greater extent reveals more complexity. Similarly to HS-2, feldspathic braided stream channel sandstones form a wedge that thickens gradually northeast into the Dry Creek minibasin (Figure 10). The channelized sandstones thin to 8 m (Figure 8) and the unit becomes more sandy and conglomeratic towards the inboard margin of the burial wedge. Conglomerates containing clasts of diapir-derived carbonate and gypsum form up to 25% of HS-3. HS-3 fills syndepositional microbasins that result in a 175% increase in thickness in HS-3 and HS-4 from 50 to 88 m (Figure 9). The microbasins contain nodular mudstones and pond limestones containing bivalves (Henness et al., 2017).

HS-4 overlies HS-3 with an angular unconformity of 3° to 15°. HS-4 is similar to HS-3 in lithology and geometry, but sections are eroded and incomplete near the diapir margin. The entire burial wedge was tilted approximately 5° to the northeast into the Dry Creek minibasin prior to deposition of the Wingate Sandstone and erosion at the J-0 unconformity has removed approximately the upper 35 m of the Chinle near the diapir (Figures 6, 7, 9 and 10). HS-4 thickens syndepositionally into the microbasins with a minimum measured thickness of 8 m and a maximum of 24 m (Figures 9 and 10).

Although much of the top of the formation was removed by erosion prior to deposition of the Wingate Sandstone, debris-flow boulder conglomerates containing diapir caprock-derived clasts in the upper part of HS-4 indicate the diapir still formed a topographic high.

**Figure 8** Isopach map of part of the Chinle Formation outcrop showing diapir margin, faults, the inboard and outboard edges of the Chinle burial wedge, and dimensions of the microbasins. The constant thickness of the Chinle in the Dry Creek minibasin to the northeast is projected from nearby well data. The abrupt thinning within the burial wedge domain represents thinning onto the topography of the diapir, and thinning, onlap and truncation of intra-Chinle halokinetic sequences HS-1 and HS-2. Two microbasins are shown by the enclosed thick in the burial wedge domain. Dashed boxes show the locations of the panoramas in Figures 9 and 10.
adjacent to the burial wedge and was still partially exposed. Paleocurrent directions measured from 70 trough cross-bed axes indicate predominant sediment transport to the southeast and south. This is the opposite of the regional paleocurrent to the north and northwest (Shawe et al., 1968; Stewart et al., 1972). Paleocurrent data indicate that the fluvial systems ran along, and towards the salt wall, suggesting that diapiric relief combined with subsidence along strike in Dry Creek minibasin redirected the channels opposite to the regional trend. The abundant caprock eroded from the salt wall and incorporated into channels also indicates a flow path along the salt wall.

5 | POST-BURIAL WEDGE DEFORMATION

The Chinle burial wedge was overlapped by a wedge of Glen Canyon Group strata (Figures 5a and 7d). Above that and to the northwest, growth strata in the latest Jurassic age Morrison Formation show subsidence on the diapir
The resulting structure forms an anticline with an axial trace that coincides with the approximate north-eastern edge of the diapir pre-burial-wedge diapir. Combined with a similar geometry on the opposite, southwestern, flank of the diapir, the LGV area formed the synclinal depositional basin containing growth strata of the Morrison Formation described above (Figure 7b). This basin is best thought of as an incipient drop-in minibasin that subsided on the former crest of the Gypsum Valley diapir in LGV (Bailey, 2020). Drop-in minibasins, alternatively termed perched synclines (Sebai et al., 2021) form when the crests of diapirs are inverted and subside to form new minibasins (Pilcher et al., 2011; Rowan, 2017).

FIGURE 10 Photopanoramas of stratigraphy of the Chinle Fm. in the Dolores River canyon. Sequence boundaries are shown with coloured lines, note onlap and truncations of bedding. The microbasins shown in Figure 9 are formed in sequences 3 and 4. Panorama locations shown in Figure 8. (a) Panorama looking east, obliquely down the canyon. (b) Panorama of same canyon wall looking north, obliquely up canyon (bedding traces in white).

of the Glen Canyon Group burial wedge. The Wingate Sandstone can be observed to onlap the top of the diapir in a few isolated outcrops.

The Jurassic Entrada burial wedge is much better exposed over a larger area. The burial wedge is preserved as a 15 to 40 m thick cover over most of LGV, representing its complete burial (Figures 4a, 5a and 7c). The burial wedge exhibits many of the same features as the Chinle burial wedge, but lacks the basal onlap and thinning onto the diapir. The basal J-2 unconformity overlies the Glen Canyon Group burial wedge, Chinle burial wedge, and diapir caprock (Figure 7c). To the southeast, in BGV, where diapirism continued throughout Entrada deposition, Entrada strata dip at up to 30° away from the diapir and onlap and pinch out against older strata upturned along the margins of the diapir rather than the caprock (Figures 3 and 5b). No conglomerates with diapir-derived clasts are found in the Entrada indicating the BGV diapir did not form an erodible topographic high. Microbasins are more pronounced on the Entrada burial wedge, having steeper limbs and greater depth than older microbasins (Ronson, 2018). However, microbasin facies are similar to adjacent Entrada aeolian facies, with isolated small pond deposits (Ronson, 2018). Unlike the Chinle burial wedge, diapiric topography is

6 | ATTRIBUTES OF OTHER GYPSUM VALLEY BURIAL WEDGES

The Triassic-Jurassic Glen Canyon Group burial wedge is poorly exposed, but the exposed facies and geographically limited geometry are similar to those of the Triassic Chinle burial wedge. Thick debris flow deposits and conglomerates composed of angular caprock clasts are exposed in the Wingate and Kayenta formations along the margins
not reflected in facies thicknesses or transport directions, likely because the tidal and aeolian units were less influenced by the minor topography.

The Morrison Formation forms burial wedges that bound BGV to the southeast (Figures 4a,b and 5b). The burial wedges are highly eroded and are offset by Neogene faults in some areas. However, outcrops illustrate burial wedge features. Like the Entrada burial wedge, the Morrison and the underlying Summerville Formation onlap and pinch out against the older strata flanking the diapir, indicating the diapir must have formed a topographic high. The onlap surface is an unconformity with underlying Entrada, Kayenta and Chinle formations truncated at angles ranging from 7° to 60° (Figure 5b). However, the upper part of the Salt Wash Member crosses unfaulted to overlie gypsic caprock. Although coarse-grained carbonate and gypsum clasts are absent, abundant coarse-grained, sand-sized clasts of black shale and dolomite are inferred to be derived from underlying Paradox caprock (Soltero, 2020). Microbasins form synclines along the margin of the diapir and contain thicker overbank mudstones.

The Salt Wash burial wedge exposes tight folds that are unique in Gypsum Valley (Figure 11). Interlimb angles of 60° imply shortening of the original depositional bed lengths. The folds are distinguished from the microbasin synclinal folds as they are smaller and tighter chevron folds (Figure 11). The axial traces trend parallel to the outboard burial wedge margin. Basal strata within synclines pinch out and onlap the limbs, indicating deformation commenced prior to or during deposition of the basal strata (Figure 11). Thinning and facies changes indicate that deformation continued as the synclines were filled (Figure 11), such that the uppermost strata in the synclines are less tightly folded than the basal strata, with synclinal interlimb angles changing from 105° at the base to 146° in the uppermost exposed strata. The strata above the anticlines have been eroded, and although deformed, the synclines do not exhibit internal faulting. Within the folds and immediately overlying strata, trough axes, exposed channel axes, and current lineations are almost uniformly to the southeast, parallel to the folds and diapir margin. This is at an approximate 45° angle to paleocurrent data from the Morrison surrounding the diapir, indicating that diapir and fold topography directed channels along the fold axes and parallel to the diapir edge.

7 | LATE DEFORMATION OF BURIAL WEDGES

Faulting is the most obvious feature above and flanking many Paradox Basin diapirs. The faults have been interpreted by some as related to solution-related collapse during the Neogene and Quaternary (Guerrero et al., 2015; Gutiérrez, 2004; Harden et al., 1985). Guerrero et al. (2015) documented Holocene solution faults in the Moab salt valley. Solution faulting appears to be more common along the Colorado River, where incision has allowed deeper dissolution of diapiric salt (Baars & Stevenson, 1981; Doelling, 1988; Doelling et al., 2000; Guerrero et al., 2015; Gutiérrez, 2004). Folding and faulting have been ascribed to interstratal dissolution within the diapiric salt (Cater, 1970; Gutiérrez, 2004). Other researchers suggest that faulting was related to contractional tectonism during the Paleogene Laramide Orogeny (Baars & Stevenson, 1981; Foxford et al., 1996; Pevear et al., 1997) or to Neogene extension (Doelling, 1988; Doelling et al., 2000; Ge, 1996; Ge & Jackson, 1998; Ge et al., 1995, 1996). Most recently counter-regional faults associated with diapir growth have been interpreted for several diapirs, including Gypsum Valley (Escosa et al., 2019; Rowan et al., 2016; Thompson Jobe et al., 2019).

Our analysis shows that Gypsum Valley exposes four types of faults (counter-regional, radial, diapir parallel and collapse), with a variety of origins (Figure 4a). A down-to-the-northeast counter-regional fault extends off the southeast end of BGV (Figure 4a). This fault is observed in seismic off the southeast end of the diapir and is interpreted as effectively coincident with the north-eastern margin of the diapir (Escosa et al., 2019; Rowan et al., 2016). The fault offsets strata as young as Late Cretaceous and has an offset of over a kilometre (Escosa et al., 2019). Radial faults are normal faults with up to 500 m of offset that extend outwards from the curved ends of the diapir (Escosa et al., 2019) (Figure 4). These are interpreted as forming through diapir doming and drape folding, which create concentric tensile stresses (Coleman et al., 2018; Escosa et al., 2019; Rowan et al., 2003). Escosa et al. (2019) interpreted these as long-lived faults that were active until at least the Late Cretaceous.

Solution-collapse faults form a graben in the centre of LGV and a set of en-echelon faults on both sides of BGV (Cater, 1955a, 1955b) (Figures 4 and 5). Offsets range up to 300 m and strata as young as the Late Cretaceous Mesa Verde Group are offset. Unlike the other faults, solution-collapse faults may exhibit strata with high dips adjacent to the faults (Figure 5a).

The most common faults in Gypsum Valley are diapir-parallel faults that typically date to Jurassic or Cretaceous and are parallel to the diapir margin (Escosa et al., 2019) (Figure 4). These faults have near vertical dips and small normal offsets and are found near the crests of the anticlines over which burial wedges are folded. Diapir-parallel faults offset burial wedge strata of Triassic and Jurassic age,
but where exposures include the latest Jurassic Morrison Formation, most terminate within the lowest beds.

8 | DISCUSSION

Recognition of burial wedges changes the understanding of the histories of diapirs and the tectonic and salt tectonic influences that shaped them. A simple history of diapiric rise, followed by synchronous burial and later solution collapse during exhumation can now be understood as diapiric rise, followed by a potentially long history of gradual burial, during which different units overlap the diapir. In the Paradox Basin, outcrops of sediment resting on diapirs have been interpreted as the tops of fault-bounded, thick collapse blocks that contain thick blocks of older strata surrounded by caprock. These are now recognized as thinned strata comprising burial wedges on the caprock and that underwent much less later deformation. Some of the important implications of burial wedges are discussed below.

8.1 | Basal unconformities

Burial wedges do not form constantly. All of the burial wedges we have observed overlie established major regional, subaerial, erosional unconformities (Figure 3). The exact cause of this is uncertain, but we have several hypotheses. First, subaerial exposure might have resulted in more rapid erosion of upwelling salt, resulting in lower net salt-supply rates to the surface. This, in turn, might have led to more gradual rise and the preservation of burial wedges. Second, differential erosion of the roof will
have preserved a thicker remnant roof and caprock near the topographically lower diapir margin. Continued salt rise may have then shifted to inboard areas where the roof was erosionally thinned or absent, so that net salt rise continued in the diapir centre while the more marginal burial wedges were preserved. Note that both hypothetical processes are more likely in nonmarine environments, such that prolonged burial of diapirs may be less common in marine settings.

8.2 | Halokinetic sequences in burial wedges

All the studied Paradox Basin burial wedges contain wedge HS. These stack, forming tapered CHS that progressively onlap or directly overlap the basal unconformity. The development of HS requires continued passive rise of the diapir and attendant drape-folding of the roof (Rowan & Giles, 2021).

Wedge CHS reflect differential rise of the diapir, with the interior rising relative to salt near the diapir margin, thereby rotating flaps of strata. Usually, the roof panels are rotated entirely off the diapir by vigorous salt rise. In burial wedges, however, rotation of the wedge HS is arrested due to the eventual cessation of rise of that part of the diapir. In the case of the Chínle burial wedge, this resulted in a wedge that thickens from 20 to 180 m over 1 km (Figures 8 and 10).

The Chínle burial wedge in LGV continued to rotate slightly during deposition of the overlying Glen Canyon Group (Figure 7d) as the more internal part of the diapir continued to rise. In contrast, in BGV, the Chínle strata pinch out against the flanks of the diapir, and at least some completely rotated HS can be observed in the minibasins flanking the diapir (Figure 5b).

8.3 | Microbasins on burial wedges

Every Paradox Basin salt burial wedge we have studied in detail has microbasins and the Chínle microbasins are good examples (Figures 5, 8 and 9). The Entrada microbasins are similar sizes as those in the Chínle; however, the Morrison microbasins are more varied, ranging from 100 to 400 m wide and 400 m to 2 km long. Microbasins require a dynamic caprock that continued to deform over hundreds of thousands of years.

Despite their prevalence, we are uncertain of the mechanism that creates microbasins in burial wedges. Although we have not identified extensive bona-fide karst-collapse features, we infer subsidence related to dissolution is probably an important mechanism for formation of the microbasins. Similar features in the Tazoult diapir in the High Atlas of Morocco have been interpreted as subsidence into karst beneath an unconformity, although these features only affect the basal beds of the overlying wedge strata (Martín-Martín et al., 2017). Longer-lived synclinal ‘sag’ basins have been shown from deeper dissolution and karst cave collapse beneath both unconsolidated sediment and lithified strata (Gutiérrez et al., 2008; McDonnell et al., 2007). The sagging of the overburden is caused by cylindrical fault collapse of karst caves (McDonnell et al., 2007), which in this case would be developed in the salt diapir and caprock evaporites. Analog models suggest similar results for salt withdrawal or dissolution of tabular bodies beneath unconsolidated sands (Ge & Jackson, 1998). Underlying dissolution can cause subsidence, but subsurface collapse is more typically expressed as faults (Ge & Jackson, 1998; Gutiérrez et al., 2008; McDonnell et al., 2007; Waltham et al., 2005).

Withdrawal of evaporites beneath the microbasins offers another mechanism by which microbasins might form. Ge and Jackson (1998) have modelled similar sag basins above withdrawal of sheets of simulated evaporites. The models and both outcrop and seismically observed solution basins exhibit an outer ring of extension and an inner zone of compression (Dias & Cabral, 2002; Ge & Jackson, 1998; Gutiérrez et al., 2008; McDonnell et al., 2007). Such features, however, have not been identified in the Gypsum Valley microbasins.

8.4 | Folding in burial wedges

The chevron geometry of the folds in the Morrison burial wedge in BGV implies shortening perpendicular to the diapir margin. The causes of the folding are uncertain as there was no regional contraction at this time. The earliest deformation precedes deposition and the strata were weak and very thin. We suggest the thin burial wedge roof strata preserve ongoing local contractual deformation of the salt caprock. One possible mechanism is gravity spreading/gliding of the elevated uppermost part of the diapir and any roof. There needs to be enough relief on the diapir to allow the salt/caprock to spread, shortening the burial wedge. Contraction is not transmitted past the outboard margin of the burial wedge, probably due to buttressing against the strong, thick minibasin. However, debris flows and large caprock clasts are not preserved, suggesting that the relief was minor. Alternatively, the folding may have been driven by conversion of anhydrite to gypsum with concomitant volume expansion and lateral contraction. However, we would expect such a process to be more widespread than the local area of folding.
8.5 Namakiers and burial wedges

Rasmussen (2014, 2016) identified a series of namakiers (salt glaciers) in both the surface and subsurface along the Paradox Basin salt walls associated with Permian and Triassic strata. Namakiers are associated with regional unconformities and erosion of the roof over the diapir, which allowed extrusive flow of salt (Rasmussen, 2014).

As both namakiers and burial wedges are present in the Paradox Basin, can they be distinguished? Strata deposited on a namaker could be mistaken for burial wedge strata and result in a misinterpretation of the diapir margin. In fact, we initially interpreted Chinle burial wedge at LGV as a namaker until evidence accumulated of burial of the diapir, rather than onlap of extrusions beyond the diapir margin. Of the four burial wedges in Gypsum Valley, the Glen Canyon and Entrada burial wedges extend across large portions of the diapir (Figures 4–6). The trace of the outboard margin of the underlying gypsum for each of the burial wedges forms a linear pattern for 10+ km along the salt wall and do not form the local, arcuate radial flow pattern shown by Rasmussen (2014) for subsurface namakiers at BGV. The Morrison Formation overlaps tilted strata (HS) at the diapir margin and extends over the diapir caprock (Figure 11) marking burial of the diapir. We also interpret the Chinle feature to be a burial wedge based on the following: (1) documented stepwise burial of the diapir (Figures 4 and 5); (2) overlap of vertical Permian Cutler strata at the base of Hamm Canyon (Figure 6f) by subhorizontal Chinle Formation strata and (3) continuation of these Chinle strata overlying diapir caprock for 13 km along the strike of the diapir. While locally burial wedges could overlie namakiers as well as the diapir itself, the geometries indicate burial was the dominant mechanism.

8.6 A model for Paradox Basin salt burial wedges

A four-stage model (Figure 12) illustrates the processes that shape burial wedges in the Paradox Basin; although they are shown as distinct stages, processes overlap in time. Burial wedge formation results in stepwise burial of the passively rising diapir and preservation of slightly rotated HS on the diapir roof. In Gypsum Valley, this resulted in formation of burial wedges during a long-lived period of reduced salt diapirism, which affected the uppermost 450 m, or approximately the top 15% of the diapir.

It is likely that this extended period of diapir burial resulted from a combination of slow net salt-supply rate (due to reduction of the salt sources in conjunction with dissolution and erosion of salt supplied to the surface) and to relatively slow and episodic deposition during the Mesozoic. The first burial wedges are found in northwestern Gypsum Valley, where the Paradox Valley diapir is located on the other side of the Dry Creek minibasin and probably was an additional outlet for salt flow, resulting in earlier welding of the Paradox salt and a lower salt supply in the Triassic than elsewhere in the diapir.

- **Stage 1**: Erosion of the roof over the diapir by regional processes produces the basal regional sequence bounding unconformity (Figure 12a). Both the diapir and any older roof strata in Gypsum Valley were bevelled by the erosion at the base of the Chinle burial wedges.
- **Stage 2**: Initial deposition of burial wedge strata took two forms, either overlap or progressive onlap (Figure 12b,c). In Gypsum Valley, basal strata of the Entrada burial wedge directly overlaps what must have been a low-relief, top-salt erosion surface. Overlapping strata, such as the Entrada, do not thin or thicken dramatically across the diapir margin. This style contrasts with the progressive onlapping, as in the Chinle and Glen Canyon Group burial wedges, which requires topography on the top of the diapir (Figure 12c).
- **Stage 3**: Syndepositional synclinal microbasins and, in some cases, contractional folding developed in the burial wedges. Microbasins are preserved primarily in overlapping strata of the burial wedge (Figure 12d,e). Contractional folding may form at the same time as microbasins (Figure 12f).
- **Stage 4**: Continued minor passive rise of the centre of the diapir relative to its margins resulted in the development of HS (Figure 12g). Before burial wedge formation, strata are drape-folded on top of the diapir. The cessation of diapir rise across the burial wedge preserves the HS on the diapir (Figures 6 and 12g).

Halokinetic drape folding at the inboard margin of the burial wedge is more difficult to document because of poor preservation due to subsequent erosion. Stages 3 and 4 can repeat themselves forming stacks of wedge HS containing microbasins and contractional folds that form a tapered CHS (CHS) in burial wedge roof assemblages. In the Chinle burial wedge, preservation of four wedge HS and thinning from 180 to 20 m occurs over the outer kilometer of the diapir top, an average slope of 9° for the base of the tapered CHS relative to its top, that is, the paleo-top of salt.

8.7 Later deformation of burial wedges

In the Paradox Basin, different kinds of later deformation have obscured the original geometry (Figure 12h–j). The most common late burial wedge deformation in the Paradox Basin was subsidence of the inboard diapir crest.
and associated downfolding of the burial wedge to form a synclinal basin over the top of the diapir (Figure 12h). This may represent diapir collapse due to dissolution or evacuation of salt into another part of the diapir that was still growing. The subsidence created an asymmetric anticline with an axial trace that corresponds to the outboard margin of the burial wedge and deeper diapir margin. Roof strata that formerly dipped away from the diapir are rotated to dip towards the centre of the diapir and synkinematic strata fill the synclinal basin (Figure 12h). Minor normal faulting near the crest of the anticline and on the limb dipping into the diapir accompanied the folding in places.

Many Paradox Basin burial wedges exhibit similar downfolding towards the centre of the diapir, including all of the burial wedges in Gypsum Valley, although the growth strata recording the folding may not be preserved in outcrop (Figures 4 and 5).

Another post-depositional process that affects burial wedges is faulting (Figure 12i). This may be caused by regional or fault bounded dissolution collapse, which may be difficult to distinguish. In addition, Laramide shortening in the Paradox Basin, caused late diapir rejuvenation and formation of subtle anticlines over the tops of the squeezed diapirs (e.g. Escosa et al., 2019).

8.8 Alternative scenarios

The burial wedges in the Paradox Basin mark the gradual end of passive diapirism. But similar stratal geometries
may occur in different settings. Burial wedges form wedge HS and tapered CHS. More typically, tapered CHS are found with steep attitudes flanking salt stocks and walls (Giles & Rowan, 2012). The basal wedge HS of such drape-folded tapered CHS are analogous to burial wedges but represent the temporary roof during ongoing passive diapirism rather than the record of progressive permanent diapir burial (Figure 12j).

Burial wedges at Gypsum Valley formed as diapirism waned. Another possibility is when the inner part of the diapir continues to rise as a steep diapir, leaving the burial wedge as the base of a salt shoulder (Giles et al., 2018).

8.9 | Competing rates

Ultimately, the geometries observed at Gypsum Valley and other Paradox Basin diapirs result from the competition between the rates of salt-rise, dissolution, erosion and sediment-accumulation. The first two combine to determine the net salt-supply rate to the surface or near surface (McGuinness & Hossack, 1993), with a possible contribution of diapir-top erosion. If the ratio between the salt-supply rate and the sediment-accumulation rate is high over a prolonged time, the diapir will continue to rise steeply and temporary burial wedges are drape folded to end up as diapir-flanking CHS. If, on the other hand, the net salt-supply rate decreases, sedimentation will gradually or abruptly overtake the ability of salt to keep pace and the diapir will be buried and eventually inactive (as in the case of Gypsum Valley).

Similarly, the interplay between salt-rise rate and salt-dissolution rate impacts the development and subsequent modification of burial wedges. If the salt-rise rate is more rapid, the top of the diapir will inflate during deposition, rotating the earlier strata, and forming HS that onlap the diapir, as with the first two Chinle HS (Figures 5c and 10). If the two rates are balanced, the roof strata will overlap the top salt with little change in thickness. If salt supply cannot keep pace with dissolution, however, the roof will collapse into the salt by some combination of folding and faulting. This can be local, as in the case of the microbasins, but can also be larger-scale, as in the incipient drop-in basin. In fact, the north-eastern flank of LGV nicely illustrates the gradually waning salt supply and thus long-term decrease in the ratio between salt-supply rate and dissolution rate: first, the Chinle and Glen Canyon strata onlap onto the still inflating salt (partial burial, Figures 7 and 12d,e); then the Entrada and Summerville strata overlap the static diapir top (final complete burial, Figure 12c) and finally the Morrison strata thicken into the centre of the diapir as dissolution outpaces any remaining salt supply (collapse, Figures 7 and 12b).

9 | SUMMARY

Burial wedges represent a hitherto undescribed halokinetic feature typically associated with late-stage passive salt diapirism. Burial wedges in the Paradox Basin formed where part of the diapir roof continued to rise, but where it never progressed to drape folds flanking the edge of a steep diapir. This produced tapered CHS that partially buried diapirs. In Gypsum Valley, burial wedges formed over a 65 my period, and express continued diapiric deformation of the sediments during deposition adjacent to a progressively narrower diapir. Recognition of burial wedges allows a reinterpretation of Paradox Basin diapirs with much less solution collapse or tectonic deformation, where much of the roof strata were syndepositionally folded in the Triassic and Jurassic and not deformed in the Neogene.

Burial wedges may contain and preserve abundant debris shed from the adjacent rising diapir, and therefore may be coarser grained than parts of the adjacent minibasin. Burial wedges develop microbasins, probably formed due to dissolution or movement of underlying salt, as well as local contractional folds formed during deposition.

Burial wedges are commonly deformed after deposition. A combination of folding and minor faulting accommodated collapse into the top of the diapir due to dissolution or evacuation of salt into a part of the diapir that was still growing. This later deformation of burial wedges may obscure their origin.

Burial wedges are not confined to the Paradox Basin, of course, because diapirs in other salt basins get buried when the supply of deep salt or contractional squeezing of the stem ceases. We have seen examples from such varied salt basins as the Gulf of Mexico, the North Sea and the Precaspian Basin. Giles et al. (2018) illustrate several examples, which at the time we grouped with salt shoulders. Other examples are described or at least illustrated in Gannaway Dalton et al. (2020); Hearon et al. (2014); Ismail-Zadeh et al. (2001); Roca et al. (2021) and Thompson Jobe et al. (2019).

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**DATA AVAILABILITY STATEMENT**
The data that supports the findings of this study are available in the supplementary material of this article.

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