Geologic History of Castle Valley, Utah

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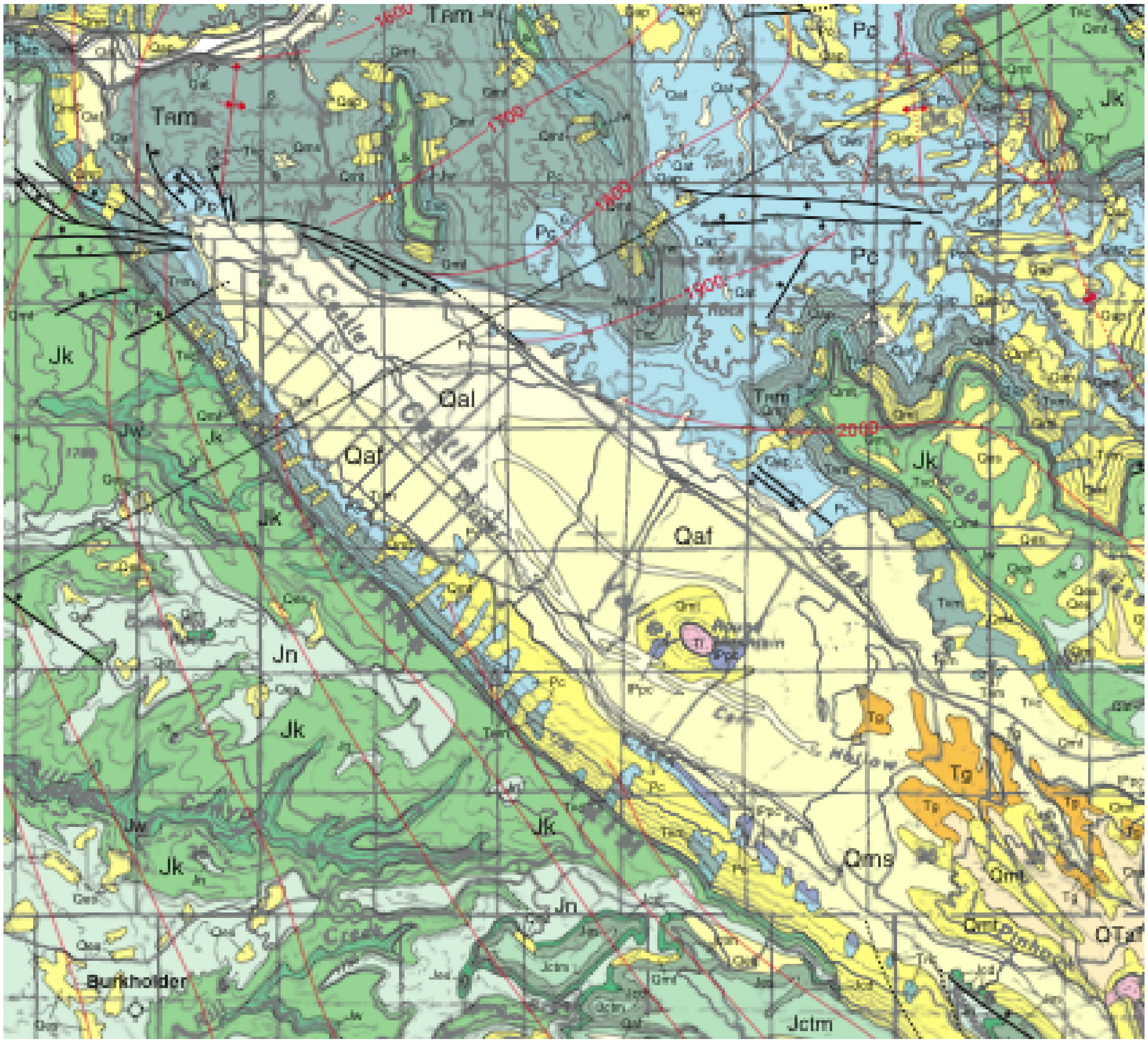

Figure 1: 1:100,000 scale Geologic Map for Castle Valley, Utah (Doelling, 2001). North is up.

Castle Valley, Utah, is a part of the more general "Canyon Country" region, which covers the southeastern quadrant of Utah and includes parts of western Colorado and northern Arizona. The rock record in this region is dominated by sedimentary deposits. In this report, I describe the general geologic history of the area, with an emphasis on Castle Valley and the formations that are currently exposed, as shown in Figure 1.

From the Cambrian to the late Cretaceous, North America had not yet separated into its own continent, and Utah was in a near-equatorial position. It was also at or near sea level, and the resulting rock record contains mostly sandstones and limestones deposited in shallow marine environments. The Uncompahgre highlands, to the east of Castle Valley, were uplifted four separate times during this period, providing a rich sediment source. As shown in Figure 3, there is a major unconformity that extends from the late Cambrian to the late Devonian, so there is no record of the Ordovician or Silurian periods at all (Barnes, 2000).

Castle Valley is one of several "salt valleys", a unique feature of the Canyon Country region. During the Pennsylvanian period, the Paradox Formation, which consists of thick crystalline salt

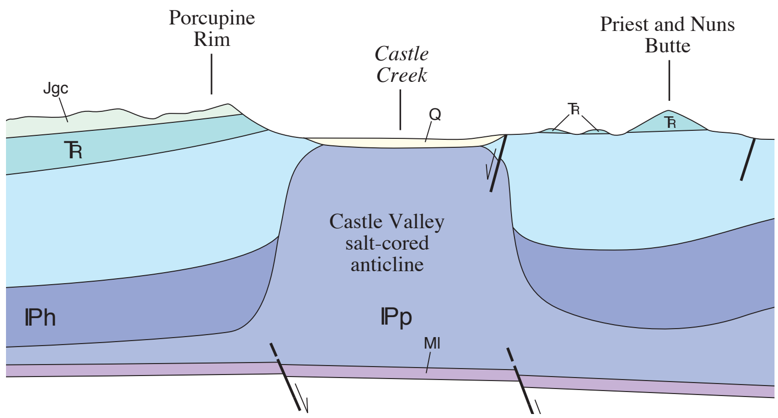

Figure 2: Transect showing the salt dome underlying Castle Valley, Utah (Doelling, 2001). This transect follows the SW-NE black line shown in Figure 1.

layers, was deposited as a result of several episodes of encroaching inland seas. The salt layers were subsequently buried, and the compressional force gradually caused the salt to flow. The salt layers mostly flowed southwest, and they occasionally encountered previously formed ridges that forced the flow upwards towards the surface, forming salt domes as shown in Figure 2. Later, when the Colorado River began to carve its way down through the overlying rock layers, it reached the salt domes and began dissolving the salt and carrying it away. As a result, the overlying rock settled lower and lower, creating the valleys. The salt domes are still present under the surface today, in some places up to 14,000 feet thick (Barnes, 2000). As the Colorado River carves deeper, it is likely to cause further settling of the valley floors.

In Castle Valley, the only exposed evidence of the Permian period is the Cutler Formation (blue area marked as Pc on the geologic map in Figure 1). This formation is composed mainly of arkosic sandstones that originated in the Uncompahgre highlands, as above (Condon, 1997).

Starting in the Triassic, some layers were deposited in a non-marine environment from the accumulation of desert dunes. The Moenkopi formation (grey region marked TrM in Figure 1) is visible in Castle Valley as red, sloping hills (Barnes, 2000). The Kayenta Formation is extensively exposed (Jk, green region). Most of the arches that this region is famous for are formed from the Wingate (Jw), Navajo (Jn), and Entrada (Jes) Formations from the late Triassic and early Jurassic periods. Locally, the “Priest and Nuns” and Castle Rock, which are tall red spires of rock that have appeared in several commercials, are a part of the Wingate Formation. The Navajo Sandstone, from the early Jurassic, is a part of one of the largest ergs (lithified dune fields) on record (Peterson, 1988), composed of sediments currently believed to have been transported from the Appalachians (Dickinson & Gehrels, 2003; Rahl et al., 2003). It appears on top of Porcupine Rim, the cliff that forms the western boundary of Castle Valley.

In the late Jurassic, North America separated from Europe, and the resulting tectonic activity caused several episodes of significant deformation and uplift in the area. In the mid-Cretaceous, seafloor spreading in the Atlantic accelerated, causing a global increase of sea level by 1500 feet (Barnes, 2000). This resulted in flooding from the southeast and the deposition of the vast Mancos Shale, which formed layers up to 3500 feet thick, but none of which remains in this area.

In the late Cretaceous, the depositional environment shifted from generally shallow marine

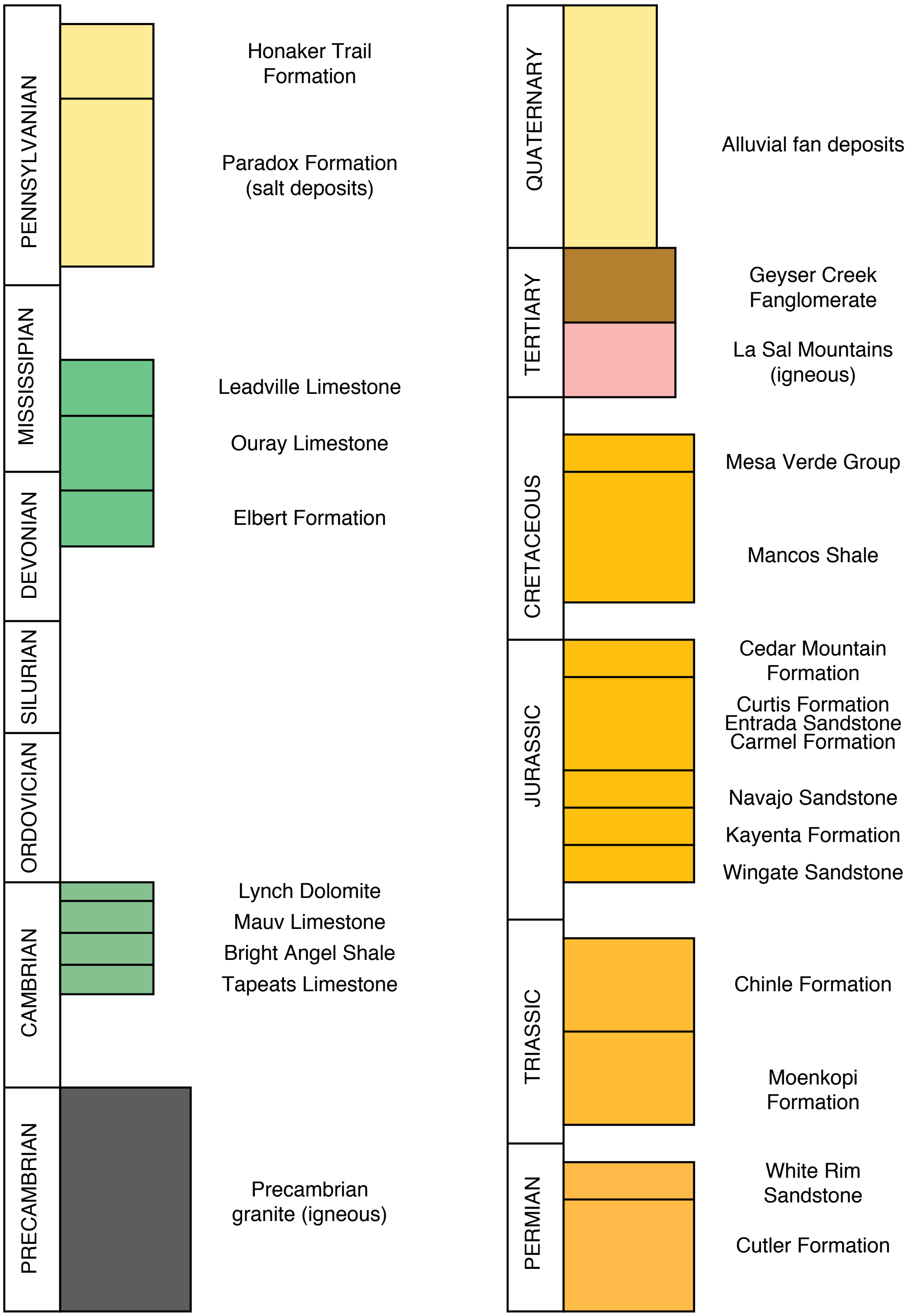

Figure 3: Stratigraphic column, with unconformities shown, for Canyon Country; derived from (Doelling, 2001) and (Barnes, 2000). With the exception of the Precambrian granite and the La Sal Mountains, all layers are sedimentary in origin.

to freshwater lakes. During the Laramide orogeny, the Rocky Mountains were created, and the Uncompahgre Uplift rose again. 24 million years ago, the La Sal mountains formed to the southeast of Castle Valley (which had not yet formed) via igneous intrusives (laccoliths; pink Ti on the map) due to the initial collision of the North America and Pacific plates (Barnes, 2000). Round Mountain, in the center of the valley, is a small outlying intrusion related to the same event. These mountains were intially just rounded uplifts, until later erosion stripped away the overlying sediments and exposed the granites to view. They are mostly hornblende-plagioclase trachyte (Ross, 1998). The unit marked Tg on the map is the Geyser Creek "Fanglomerate", which is composed of debris from the La Sals.

10 million years ago, the entire area from the Sierra Nevadas to the eastern edge of the Rocky Mountains experienced a gradual, massive uplift (about a mile in total). The Colorado River, which previously flowed over the mostly flat terrain in large meanders, began cutting deeply into the sandstone layers due to the elevation change. The rise was fast enough that the meanders became "entrenched", resulting in the deep, sheer canyons that we observe today (Barnes, 2000). During the last ice age (800,000 to 10,000 years ago), glaciers appeared in the La Sal Mountains and left glacial moraines and till that are still visible, though not in Castle Valley itself.

The remaining areas on the geologic map are quaternary, deposited mostly as alluvial fans from the surrounding cliff walls (Qaf, Qmt) and alluvial deposits from Castle Creek (Qal), which runs through the valley. The house where I grew up in positioned in the northwestern corner of the valley, on alluvial fan debris.

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