**Appendix:**

**Formal Designation of the Sagehen Formation and the Benton Crossing Formation**

**Intent and Utility.---**The intracaldera sedimentary package in Long Valley Caldera, Mono County, California, USA, is herein formally assigned to two coeval lithostratigraphic units. These units hold significance for understanding the evolution of the Long Valley system following the caldera-formation eruption of the Bishop Tuff, and they also appear to contain a valuable record of regional paleoclimate. Thus, formal designation will facilitate future work involving these deposits.

**Category and Rank.---**These units are designated as lithostratigraphic formations.

**Names.---**The volcaniclastic portion of the package is named the Sagehen Formation, as the most representative outcrops are located along Hot Creek near Sagehen Road. (This road name is documented in the GIS database of Battaglia et al. [2003].) The fine-grained portion of the sedimentary package (dominantly diatomites, marls, and volcaniclastic siltstones) is named the Benton Crossing Formation, as the most representative outcrops are located along Benton Crossing Road.

**Type Sections.---**The type section for the Sagehen Formation is located along Hot Creek at 0340512mE 4171291mN 2119m, NAD83 UTM11N. The type section for the Benton Crossing Formation is located north of Benton Crossing Road and east of the Owens River at 0344632mE 4175273mN 2094m, NAD83 UTM11N. Figure A1 shows measured sections for these formations along with field photographs of the type sections. Figure A2 shows the locations of these type sections.

**Descriptions.---**Volcaniclastic mudstones; volcarenite and feldspathic volcarenite sandstones; volcaniclastic conglomerates; and shoreline carbonate deposits constitute the Sagehen Formation. Sandstones may be planar bedded, trough cross-bedded, or massive. The constituent sand is generally moderately to poorly sorted and subangular to subrounded. Sandstones and conglomerates may be graded or nongraded. Clasts are dominantly composed of silica glass or aphyric rhyolite fragments, although quartz, feldspar, and mica clasts are also present. Clastic outcrops typically form short cliffs (3-5 m). Rock units weather gray or brown and are dark gray to white on fresh surfaces. The sandstones and conglomerates are cemented to varying degrees by authigenic silica. Finer sand units tend to be lighter in color and are often more thoroughly cemented by silica. The mudstones and sandstones often contain silicified plant rootlets and stalks. The shoreline carbonate deposits are commonly massive and off-white to brownish or reddish white. At the type locality, planar-bedded sandstones display the topset-foreset architecture that is diagnostic of Gilbert-type deltas (Fig. A1). The outcrop displays an unusual style of erosion where the sediment along specific intervals has preferentially weathered away, regardless of grain size or clast composition, and left recessed voids that discontinuously follow bedding.

Fine-grained biogenic and chemical sediments as well as volcanic ash constitute the Benton Crossing Formation. The biogenic sediments include diatomite and ostracod carapace clasts. Chemical sediments are calcareous. These deposits may include abundant calcareous precipitate or may be composed entirely of biogenic sediments. Good exposures of this formation are rare, as outcrops are often highly eroded due to the soft and poorly consolidated nature of the constituent sediments. The deposits are often gray-white on weathered surfaces and may contain a small volcaniclastic silt fraction (< 15%) and sparse fine- to coarse-grained volcaniclastic sand.

**Boundaries and Geographic Extent.---**As the two formations contain distinctly different sediment suites, the boundary between these units naturally falls at the interface between deposits that are dominantly volcaniclastic in composition and deposits that are dominantly composed of biogenic sediment, fine chemical sediment, and volcaniclastic silt. The boundary between the Long Valley volcanic suite and the Benton Crossing Formation is similarly naturally defined as the interface between volcanogenic deposits and fine-grained sediments. (This transition does not appear to be exposed in surface outcrops.) However, the boundary between the volcanics and the Sagehen Formation is less clear because of the challenges in discerning sediment gravity flows from subaqueous pyroclastic flows. In this case, deposits of the Sagehen Formation can be recognized as being composed of epiclastic sediments rather than highly angular, intergrown, and possibly fused pyroclasts. In terms of geographic extent, the Sagehen and Benton Crossing Formations are limited to within the topographic expression of the caldera. Surface outcrops are dominantly located in the central and eastern portions of the caldera (Fig. A2), but these formation may also extend westward in the subsurface.

**Historical Background.---**Rinehart and Ross (1964) first mapped the bulk lacustrine sedimentary package. Bailey et al. (1976) briefly reviewed the major lithologies in the sedimentary package in a broad study of the rock units, structure, and geologic history of Long Valley. Fournier (1989) examined these deposits in cores and cuttings from two boreholes. Beeler et al. (2010) examined the exposed intracaldera sandstones and conglomerates with a focus on the development of hydrothermal silica cements.

**Age.---**The formation of the Long Valley Caldera constrains the maximum age of the Sagehen and Benton Crossing Formations to be less than 760 ka. As the timing of the drainage of Long Valley Lake remains uncertain, there are no firm constraints on the minimum age for the formations.

**Genesis.---**The Sagehen Formation represents shoreline and near-shore deposition of coarse sediment and calcareous precipitate in the intracaldera Long Valley Lake. The Benton Crossing Formation records accumulation of pelagic sediments in the central portions of the lake as well as the input of volcanic ash.

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**FIGURE CAPTIONS**

Figure A1: **A**) Measured section from the Sagehen Formation type locality. **B**) Image of the Sagehen Formation type section. Note the irregular pattern of erosion. **C**) Image of the Benton Crossing Formation type section. **D**) Measured section from the Benton Crossing Formation type locality. **E**) Overview image of the Sagehen Formation type locality in cliffs along Hot Creek. The Gilbert-type delta topset-foreset bed architecture is clearly apparent. Scale bar in each image is 1 meter.

Figure A2: Map showing the locations of the type localities for these two formations. The Sagehen Formation type section is located at 0340512mE 4171291mN 2119m (NAD83 UTM11N). The Benton Crossing Formation type section is located at 0344632mE 4175273mN 2094m (NAD83 UTM11N).