A Composite Depth Scale for Sediments from Crevice Lake, Montana

By J.G. Rosenbaum, G. Skipp, J. Honke, and C. Chapman

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Conversion Factors

SI to Inch/Pound

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
meter (m)	3.281	foot (ft)
	Area	
hectare (ha)	2.471	acre

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Introduction

As part of a study to derive records of past environmental change from lake sediments in the western United States, a set of cores was collected from Crevice Lake, Montana, in late February and early March 2001. Crevice Lake (latitude 45.000N, longitude 110.578W, elevation 1,713 meters (m)) lies adjacent to the Yellowstone River at the north edge of Yellowstone National Park (fig. 1). The lake is more than 31 m deep and has a surface area of 7.76 hectares. The combination of small surface area and significant depth promotes anoxic bottom-water conditions that preserve annual laminations (varves) in the sediment.

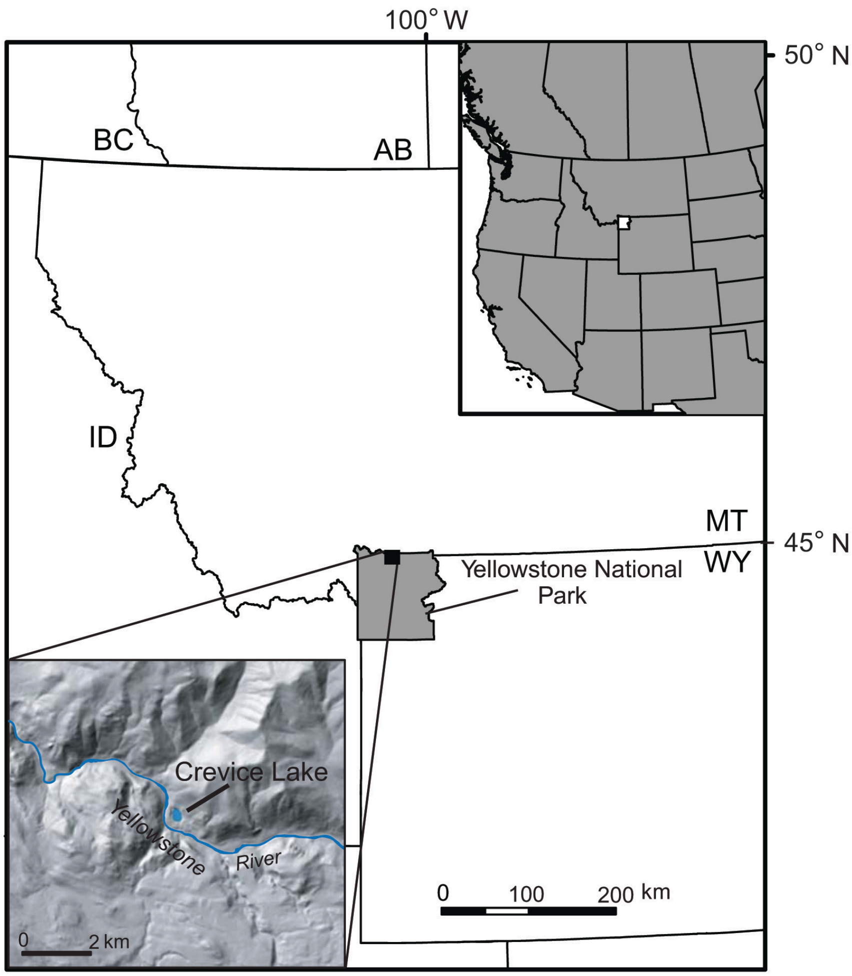

Figure 1. Location of Crevice Lake.

Three types of cores were collected through the ice. The uppermost sediments were obtained in freeze cores (Glew and others, 2001) that preserved the sediment water interface (fig. 2). Two sites were cored with a 5-centimeter (cm) diameter Livingstone corer (Glew and others, 2001). Five cores were taken with a 2-m-long percussion piston corer. The percussion core (manufactured by UWITEC) uses a plastic core liner with an inside diameter of 9 cm. Coring was carried out at two sites. Cores A and B were taken from site 1 and cores C, D, and E from site 2 (table 1). Cores A – D each consist of three overlapping sections. Core E is made up of a single section. Because of the relatively large diameter of the percussion cores, samples from these cores were used for a variety of analyses including pollen, charcoal, diatoms, stable isotopes, organic and inorganic carbon, elemental analyses, and magnetic properties. As explained below, portions of various percussion core segments were spliced to form a composite section. The purposes of this report are to provide a depth scale for that composite section and to establish a method of conversion between sample nomenclature and that depth scale.

Figure 2. Freeze core of varved sediments from Crevice Lake.

Table 1. Percussion Cores Taken from Crevice Lake, Montana.

Site number	Water depth (meter)	Core	Location[1]	Segment	Approximate cored interval (meters below lake surface)	Recovery (meter)
1	27.57	CV01A	45.00043N 110.57827W	1	27.87 – 29.93	1.91
				2	29.93 – 31.99	1.90
				3	31.99 – 33.27	0.81
		CV01B	2 meters southwest of CV01A	1	28.72 – 30.66	1.79
				2	30.66 – 32.72	1.65
				3	31.66 – 33.72	1.56
2	27.37	CV01C	45.00057N 110.57862W	1	27.57 – 29.63	1.90
				2	29.63 – 31.69	1.63
				3	31.69 – 33.75	1.63
		CV01D	1 meter west of CV01C	1	28.57 – 30.63	1.90
				2	30.63 – 32.69	1.90
			2 meter south of CV01D	3	32.69 – 34.63	1.70
		CV01E		1	34.19 – 35.93	1.55

[1]Latitude and longitude from global positioning system; datum is World Geodetic System 84.

Methods

The percussion piston corer is suspended on a cable system and lowered through the water column. If coring is to begin below the sediment water interface, the piston remains locked in place at the lower end of the core barrel while the barrel is driven into the sediment by repeatedly dropping a hammer weight. At the desired depth, the piston is released and held at a fixed depth by a cable to the surface while the barrel is driven further into the sediment.

Sampling was done in two stages. An initial stage of sampling was carried out at the University of Nebraska. During that stage, the upper 99.8 cm of segment CV01A-1 was sliced into 289 specimens that were interpreted to represent the past 2,650 years (Whitlock and others, 2008). A second stage of sampling took place at the U.S. Geological Survey in Denver. During the second stage, the remaining core was split lengthwise, cleaned, described and photographed. For each segment except CV01A-1, scales for photographs and subsequent sampling were set so that 0 cm was aligned with the top of the plastic core liner (fig. 3, in separate file). The scale for segment CV01A-1 was arbitrarily set so that the top of the unsampled portion was at 77.5 cm. For the second stage of sampling, sample names consist of core, segment, and interval on the scale (for example, C-2 77-77.5 is a sample from 77-77.5 cm within segment 2 of core C). Visual inspection of the sliced core shows that coring deformed the sediment to varying degrees. Laminae in some zones are nearly flat, whereas those in other zones are convex upward. Sampling by horizontal sectioning of severely deformed core is not desirable, therefore, a composite section was established to sample the entire cored section using the least deformed sediment (fig. 3).

To establish a composite section, core segments were first roughly aligned on the basis of depths from coring notes and then more precisely aligned by visually correlating distinctive features among various core segments (fig. 3). Depths estimated from coring notes have potential errors from uncertainties in initial field measurement and because of core loss and deformation. The features used for correlation include packages of rhythmically layered sediments (for example, in segments CV01A-1 and CV01B-1), an ash layer (at 1.80 m and 0.91 m in segments CV01B-1 and CV01C-2, respectively), and contacts between rhythmically layered and massive sediment (for example, near base of segment CV01C-2 and top of segment CV01B-2). After correlating cores, a composite section was established by incorporating the least deformed core in each stratigraphic interval.

Results

The presence of distinctive packages of rhythmically layered sediment allowed straightforward correlation among most core segments. The only questionable correlation used for transferring the composite section from one core segment to another occurs at the contact between a massive gray unit (above) and a brecciated unit (below). This contact was interpreted to occur at 1.28 m in CV01C-3, 0.38 m in CV01D-3, and 0.70 m in CV01B-3 (fig. 3).

Distinctive laminae in rhythmically layered sediments in the upper portion of core segment CV01A-1 (which was sampled at the University of Nebraska) were visually correlated with those in a freeze core that preserved the sediment water/interface. In this manner the top of segment CV01A-1 was determined to be 11.9 cm below the sediment/water interface. As stated previously, the upper 99.8 cm of segment CV01A-1 were sampled at the University of Nebraska during the first stage of sampling. The top of the portion of segment CV01A-1 sampled during the second phase at the USGS in Denver therefore is at a depth of 111.7 cm (11.9 + 99.8; table 2). The depth below lake floor of a horizon within the composite section is simply the cumulative thickness of sediment in the composite section sampled during the second phase plus 111.7 cm (fig. 3). For CV01A-1, the difference between 111.7 cm and the scale reading for the top of this segment (78 cm) yields an "adjustment" of 33.7 cm to convert scale readings to depths below lake floor. Similar adjustments were calculated in a sequential manner for each core segment used in the composite section (table 2).

Table 2. Depth Adjustments for Converting Depth in Segment to Depth in Composite Section.

Core segment	Transition from segment[1]	Depth of transition in composite section (centimeters below lake floor)[1]	Scale reading of transition in segment (centimeter)[1]	Adjustment to composite depth scale (centimeter)[1]
CV01A-1	Upper part of CV01A-1[3]	111.7	78.0	33.7
CV01B-1	CV01A-1	212.7	80.0	132.7
CV01C-2	CV01B-1	222.2	0.0	222.2
CV01B-2	CV01C-2	372.7	13.0	359.7
CV01C-3	CV01B-2	463.2	46.0	417.2
CV01D-3	CV01C-3	545.2	38.5	506.7
CV01E-3	CV01D-3	666.7	10.0	656.7

[1]See figure 3.

[2]Add adjustment to scale reading to obtain depth below lake floor (blf) in composite section.

[3]See text.

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