A Land Pocked With Kettles

John C. Holden

We live in a topographically diverse area in Okanogan County. There are sand flats, sand dunes, terraces, coulees, and much more, not to mention the much older "basement" rocks underlying all. Here we will consider one class of surface glacial features, namely the many circular depressions commonly encountered on the sands and gravels blanketing much of the lowlands of Okanogan Valley. But first, a little background.

Prior to human history in our area there is an earlier and fascinating geologic history culminating at the end of the latest Pleistocene ice advance. Most of the Okanogan Valley floor, and adjacent areas, show the direct effects of this ice and subsequent stream activity from the melting ice sheets that blanketed Canada in its entirety as well as all of Okanogan County. There were many ice surges in the 2.6 million year Pleistocene Epoch, each lasting about 85-90,000 years followed by an "interglacial stage" of about 10,000 to 15,000 years, or more, only to experience yet another ice surge thereafter. We are presently living near the end of the latest interglacial stage. We should be humbled by the realization that eventually the ice will move and cover our region once again as it has so many times in the past.

18,000 years ago at the continental glacier's maximum extent, over a mile thick of ice covered the area and extended down to Chelan and over to Coulee City. Only the highest peaks poked through the frozen white mass which extended much further south at higher elevations along the Cascades. When the ice began to recede 18,000 ago mountains emerged leaving an actively moving glacier, known as the Okanogan ice Lobe, traversing the Okanogan Valley down to the latitude of Chelan. Massive amounts of water roared along the flanks of this ice lobe as western Canada was drained of its melting glaciers. Indeed, the Okanogan Valley was a major route for the escape of this water. This flood water brought copious amounts of sands, gravels, and boulders so abundantly obvious to those of us who now live on the valley floor. As the ice lobe became smaller, the flood waters deposited progressively lower terraces (so called *kame terraces*) along its flanks, accounting for the step-like topography that we see on both sides of the valley today.

Chunks of glacial ice, both small and large, were carried along by the torrents of meltwater in the valley floors. As these waters became shallower toward the close of the great Pleistocene melting, rafted ice would go aground and become stranded. Incoming sediment was then deposited around and on top of them. After the buried ice melted, a *kettle* was formed: a circular depression (from the middle English *ketel*, originally from the Latin for "large bowl"). The size of these features varies from a few tens of feet across to 5 miles wide. Most of the kettles in our area are a few hundreds of yards wide (the really big ones occur back in Minnesota). Kettles are abundant from Malott to Tonasket and readily seen along U.S. Route 97.

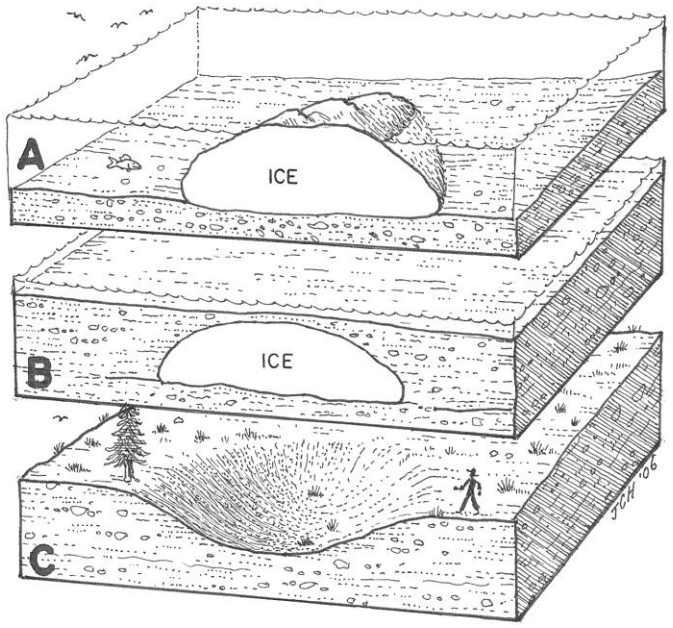

Figure 1 - Kettles from rafted ice. **A.** A large chunk of ice brought in by glacial melt waters goes aground. **B.** Flood waters begin to recede but sediment is deposited on and around the ice. **C.** The ice melts leaving a circular or oblong depression with "interior drainage", i.e., an enclosed basin.

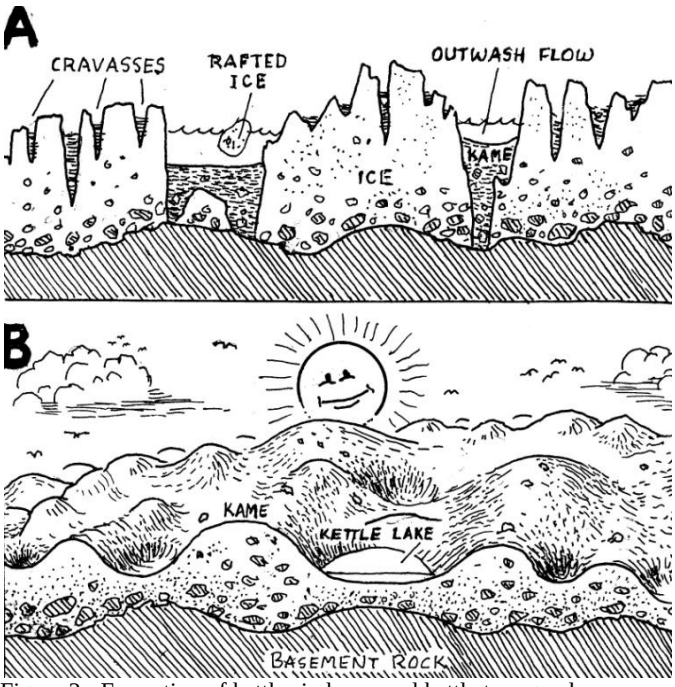

Figure 2 - Formation of kettles in kame and kettle topography. **A.** decaying non-moving glacier (of thicknesses of less than 165 feet). Outwash deposits kame in the lower parts of the irregular topography. **B.** Hilly topography was once depressions in the decaying ice. The kettles were the last to melt receiving no outwash.

There are many near the Okanogan County Historical Society's "The Curtis Sheep Slaughter" road-stop monument just north of the Malott exit on both sides of the road. From this vantage point the end of Pleasant Valley

can be seen to the southwest where State Route 20 leaves the Okanogan Valley on its way to Loup Loup Pass. In the late Pleistocene a tributary glacier in this valley merged with the Okanogan Ice Lobe in the Okanogan Valley. Pleasant Valley is higher than the Okanogan Valley floor and ends as an abrupt grade. It is perched, so to speak, at a higher elevation than the latter. This is called a hanging valley - a morphological feature common, but much broader in width, to the narrow hanging valleys in high mountainous "alpine" glacial regions. Interestingly, the Okanogan Valley combines glacial features typically found only in mountainous "alpine" glacial topography with features typically found only in lower and broader glaciated regions such as the American Midwest. Hanging valleys and valley trains (see below) belong to the former regions, whereas kettles and kame terraces belong to the latter regions, but we have them both due to our in-between topography. Most of the major valleys draining into the Okanogan Valley are *hanging valleys* with fairly abrupt mouths.

A small kettle just south of the Okanogan County Historical Society's "The Curtis Sheep Slaughter" monument near the Malott exit off U.S. Route 97. The feature is about 200 feet in diameter and 20 feet deep. The Pleasant Valley "hanging valley" is in the background.

North of the Curtis Sheep Slaughter monument (on the old highway that runs past the county landfill) are more kettles. This one is about 600 feet in diameter and 100 feet deep.

Between Riverside and Janis Bridge (four miles south of Tonasket) the Okanogan Valley is composed of two channels divided by a ridge (Short Mountain). U.S. Route 97 runs the length of the western channel called Wagonroad Coulee that contains many kettles. Geologically, Wagonroad Coulee is known as a valley train, a term usually restricted to narrow mountainous alpine glacial valleys dominated by outwash sediments - sands, gravels, and well-rounded cobbles and boulders. These sediments are clearly evident along the road cuts in Wagonroad Coulee. The western edge of Wagonroad Coulee is at a lower elevation than the eastern edge occupied by Route 97. The kettles along the highway are small ones and were the result of (1) stranded ice from the decaying glacier surrounded by glacial in-wash while there was still a sizable ice lobe to the west or (2) by ice rafted in on melting ice. Kettles are also developed on *kame terraces* - a terrace deposited adjacent to ice. ("kame" is the general term for unstratified as well as stratified glacial outwash). Two large kettles occupy the western edge of Wagonroad Coulee. A picturesque one that can be seen on the west side of the highway is Crumbacher Lake, six miles north of Riverside. Like many large kettles, this one contains a lake. Crumbacher Lake is a *kettle lake*. The thousand foot long Booher Lake, four miles north of Riverside at the base of the limebelt, is another kettle lake. When a kettle is low enough to tap into the water table, bingo, a kettle lake! Instead of ice being rafted in, these larger kettles were probably formed by stagnant ice, i.e., the terminus of a non-moving ice sheet in the form of a valley ice lobe no longer being fed by the shrinking ice mass to the north, that was then covered by melt water outwash and, of course, when the buried ice finally melted, these two large kettles were formed.

So far we've been talking about kettles on the fairly flat lower valley floors sculpted by copious outwash from the melting ice sheet. But kettles also formed at higher elevations where the incredibly dirty stagnant melting glacial ice dropped its load amongst an irregular topography of rotting ice. Depressions in this rugged terrain received abundant deposition but the remaining blocks of ice got none. When all the ice was finally gone there were depressions (Kettles) with adjacent hills (kames). Both are present in *Kame and Kettle topography.*

These are just a few areas where kettles can be seen. Armed with this information, many more can be discovered in the Okanogan Valley region by anyone curious to seek them out. Beware there are many pot holes in the region that aren't kettles at all. Such is the case in the Cameron Lake area littered with pot holes that are not kettles. There the depressions appear to occur on granitic basement rock that has been glacially quarried (also known as "plucked") by thick moving ice. In the Cameron Lake region there is a minimum, or complete absence, of glacial sediment and the basins occur in, and are surrounded by, granite. Without glacially derived sediment, kettles can't form. Happy kettle hunting!

Meet the Author

John Holden is a retired scientist & former faculty member of Wenatchee Valley College-Omak, where he taught Geology, Meteorology & Astronomy, among other subjects. He was educated at San Diego State University (Geology) & the University of California-Berkeley (Paleontology). He is an accomplished illustrator, whose drawings & sketches have been published in many scientific journals & textbooks. John has lived in Okanogan County for 38 years - 15 in the Methow Valley, 23 in the Okanogan Valley. He and his wife Linda currently live off the grid on the western slope of Omak Mountain in Wannacut Basin.