

## INTRODUCTION

The following articles have been modified from the originals published in *Okanogan County Heritage* magazine by John C. (“Jack”) Holden. Jack developed these geological interpretations over the past several years during field trips throughout Okanogan County as a member of the “Friends Of the Okanogan Lobe” (FOOLs, for short). For more on the FOOLs go online: Rocks In Their Heads, Wenatchee World.

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## PENNY GEOLOGIC TIME MODEL

There are many ways to graphically represent geologic time. The one I designed and used in my classes when I taught involves money. Let the thickness of a U.S. penny represent 1,000 years. Ten dollars of pennies (1,000 of them) would be equal to one million years, a stack of pennies five feet high.

The Pleistocene Epoch, containing our “ice age,” has recently been officially set at 2,588,000 years, but the ice sheets (continental glaciation) only occurred in the past 1.8 million years or so. These ice sheets consisted of about 30 or more ice advances, each terminated by an interglacial stage of global warming. All 30 or more ice advances are equivalent to a stack of pennies nine feet high. Incidentally, all the glacial features we see in Okanogan County were formed only in the last ice advance beginning 100,000 years ago. Those 100,000 years can be represented by a stack of pennies six inches tall. All the features made by previous ice sheets were swept away by succeeding ones.

The last five ice advances are about 100,000 years in length. All the earlier ones were less severe and of shorter intervals. These intervals are now believed to be caused by Earth rotational and orbital dynamics around the Sun due to the interplay of all the planets in the solar system. The Earth’s (1) eccentric path around the Sun goes from eccentric to almost circular every 97,000 years, (2) tilt to the ecliptic varies from 22 to 25 degrees every 43,000 years and, (3) rotational pole precesses every 24,000 years. Collectively these are the “Milankovitch Cycle” (My figures are approximate).

White on the penny model represents how much ice was on land based on oxygen-16/oxygen-18 ratios derived from the CaCO<sub>3</sub> shells of foraminifera from deep sea cores. Since seawater molecules made from the heavier O-18 are less prone to evaporate and therefore become more concentrated in the ocean during Earth cold spells, the foraminifera used more of them constructing their tiny shells then. Geochemists can measure these things!

For a longer view of time, the age of the earth is thought to be 4,550 million years old. At five feet per million years that would be a stack of pennies 22,750 feet high. The “Big Bang” is a stack 67,000 feet high or over 12.5 miles.