

# Expanded Secondary Craters as Evidence for Ancient Subsurface Ice

Large impact events can toss up chunks of material that re-impact the surface, forming a radial distribution of smaller craters called secondary craters, or simply “secondaries”.

In a region of the northern plains of Mars called Arcadia Planitia, we observe secondary craters with edges that appear to have “expanded” (top left). We think this is caused by sublimation, or the conversion of a layer of fairly pure subsurface ice into gaseous water vapor after the ice layer was exposed to the atmosphere when the craters formed. The source of these expanded secondaries appear to be four larger craters that are between 20 and 70 million years old based on crater counts. Therefore, subsurface ice throughout this region must be at least that old, and is still preserved beneath an upper layer of dry material. Some areas, like the ejecta of the older crater shown to the left, preserve larger expanded secondaries than the surrounding terrain, possibly because the subsurface ice layer is thicker.

We estimate that a volume of at least 6000 cubic kilometers (1500 cubic miles) of ancient ice remains in the near subsurface of Arcadia Planitia. This could be a promising source of water for future human explorers on Mars.

Viola et al. (2015). *Icarus* 248, pp.190-204.

