THE AGES OF OUR VOLCANOES

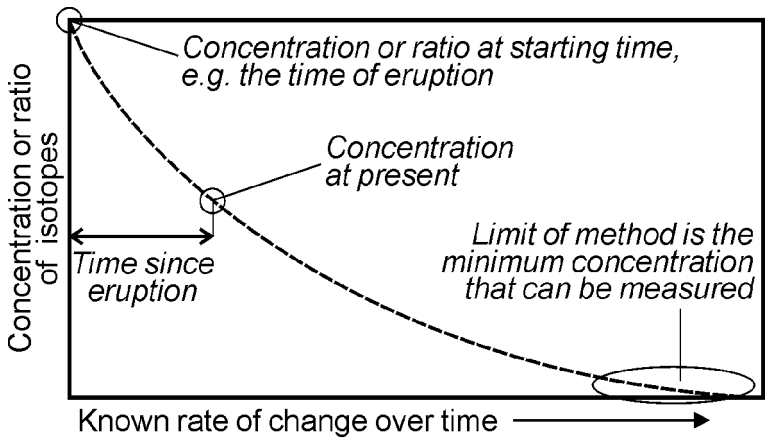
Compiled by Ken Grimes, Hamilton Field Naturalists Club, June 2007.

There is some confusion concerning the ages of the various volcanoes near Hamilton. Part of the problem is that many of the dates cited in the scientific reports for the younger volcanoes are "minimum" ages based on dating of swamp deposits that formed after the actual eruption. The other problem is that the geologists are constantly collecting new samples and trying new methods so the dates keep getting revised, usually to an older age.

Numeric dates are generally obtained by measuring some factor, such as the quantity of a radioactive isotope, that changes at an orderly and known rate from a known or predictable starting value. The degree of change can then be converted by a formula to the amount of time that has elapsed since the process started. Various problems can introduce errors or reduce the accuracy of the result: e.g. determining the exact starting state, ensuring that there has been no loss of the material being measured or introduction of foreign material, and allowing for factors that might vary the rate of change through time.

The ideal situation is where we can get an isotope date on the actual volcanic rock, which is basalt lava or scoria. The most common method for doing this is the Potassium/Argon (K/Ar) method. This method measures the decay of a radioactive isotope of potassium (K) to its daughter isotope, argon (Ar). At the time of the eruption any argon, which is a gas, is bubbled off from the lava so we start with zero and the amount builds up at a known rate. By measuring the ratio of the two isotopes we can calculate how long the rock has been solid. Unfortunately, this method is only useful for basalts older that about 100,000 years - for younger basalts not enough of the argon has built up in the rock to measure accurately unless you can afford some very fancy equipment.

Radiocarbon is another method that uses the radioactive isotope: carbon-14. This has a known quantity in the air, and after it is incorporated into organic material (e.g. wood, bone or shell) it decays at a known rate. By measuring how much is left we can calculate how long it has been since the organism was alive (see figure). Errors can result from contamination by modern organic material.



Example of how we can estimate the age of a rock if we know the rate at which a radioactive isotope decays, or the rate of any other physical process and its starting level.

More recently a new dating method has been discovered which measures the build up of isotopes on the surface of a lava flow as a result of cosmic radiation that has been hitting it since it formed.

As it is difficult to get accurate K/Ar isotope dates directly from very young basalt lavas, many of the ages quoted for these have been based on radiocarbon dating of organic material from associated sediments - typically lake sediments within the craters, or peat deposits in swamps that were dammed up by lava flows down valleys. In both those situations the age estimate is a "minimum" one as the sediments are younger than the actual eruption by an unknown time. The original author may have discussed the relationships and the probability of the date being close to that of the actual eruption, but these discussions are seldom repeated when the date gets quoted elsewhere and people tend to forget that these are minimum ages - simply quoting the number as the actual date of the eruption. In several cases volcanoes that were once thought to be relatively young (from minimum ages) have had their ages pushed back when further material was found and dated. An example is Mt Napier, long referred to as "about 7000 years old" on the basis of a minimum radiocarbon age from Buckley Swamp, but recently re-dated to 32,000 years.

Ages of some local Volcanoes

As thought correct in 2007

The following represents our current understanding of the ages of some of the volcanoes in the western part of the region, but could change as new ideas and data appear!

Mount Gambier (4,300 or over 28,000 years - a conflict).

Mount Gambier was once thought to be the youngest volcano in the region at about 4,300 BP. That was based on several radiocarbon dates from soils buried beneath the ash deposits. However, its age has been recently pushed back to over 28,000 years following radiocarbon dating of sediments in cores taken from the floor of Blue Lake by Leaney, & others in 1995. Not everyone is happy with the new date, however, which conflicts with the earlier ones. Possibly there were two eruptions (as suggested by Sherwood, & others, 2004) but it is difficult to see how the widespread ash (which buries the younger dated material) could have formed without destruction or burial of the older dated lake sediments. More work is needed here.

Mount Schank (5,000 years?)

The suggested change in the age of Mt. Gambier would to leave Mount Schank as the youngest volcano in the province, based on a thermoluminescence date of 5,000 years from the sands underlying it. Thermoluminescence is an effect that builds up in quartz grains with time as a consequence of radioactivity, but is reset by exposure of the grains to heat or sunlight, so it measures the time since the sand was buried by the volcano. This is a less reliable method so the date is best used with some caution.

Mount Eccles. (33,000 years old)

The history of dating efforts here is an excellent example of how ideas change with time. The initial estimates of the age were made by Gill & Gibbons in 1969. In the Condah swamp at Breakaway Creek, swamp and pond deposits overlie a basalt lava flow that could either have come down the valley from Mount Napier, or (more likely) have backed up it from Mount Eccles. The peat here was dated by radiocarbon at 6235 BP which provided a minimum age for the underlying basalt flow. (BP = Before Present, where "Present" = 1950 AD).

The Tyrendarra lava flow from Mt. Eccles extends offshore to depths of 18 fathoms (33m) indicating that that part of the continental shelf was dry at the time of the flow. The rising post-glacial sea would have reached this depth about 9,000 years ago providing a minimum age of that flow. Gill (1979) reported a 19,300 BP radiocarbon date from wood in a river bed that underlies the Tyrendarra flow at Ettrick, east of Heywood, indicating a maximum age for the flow at that spot. These two estimates seemed to "bracket" the age of the Tyrendarra lava flow.

In 1981 Ollier reported a minimum age of 19,750 for roots in a soil horizon buried beneath the eastern edge of the main scoria cone of Mount Eccles (the pale band visible near the base of the big quarry face). However the sample was very small and so the date had a very large statistical error range (up to 50,000 maximum**!**). So that date is not very useful. Ollier reviewed the earlier dates and suggested that there could have been at least two stages to the eruption: one about 20,000 years ago formed the scoria cone and the oldest of the Tyrendarra flows, and possibly a younger set of flows about 7000 years ago, though these younger dates were only minimum ages based on the swamp data.

More recently, several dates from Condah Swamp by Head & others (1991) indicate an earlier (pre 27,000) date for swamp formation, which is still presumed to postdate the onset of the volcanism. Basal lake muds and peat as old as 27,500 years were found in Condah Swamp and Wittlebury Swamp, but Lake Condah does not appear to have formed until about 8,000 years ago. This indicated a minimum age of 27,000 years for the lava flows, and cast some doubt on Gill's 19,300 (maximum) date for the Tyrendarra flow (the most likely cause of the swamp) unless it was from a later eruption from the same centre.

Finally, in 2004 geologists from Monash University extracted a core of the sediments on the floor of Lake Surprise. Preliminary, unpublished, information from radiocarbon dating of this material suggests that the crater formed at least 33,000 years ago - but work is continuing.

Mount Napier. (32,000 years)

For a long time Mount Napier was poorly dated. The only date was from Buckley Swamp to the northeast, where a single 7230 BP radiocarbon date was reported from the base of the peat by Gill & Elmore in 1973. As this swamp would have been dammed up by a lava flow from Mount Napier, the date gives a minimum age for the flow. In the absence of any better data many people tended to refer to the volcano as being "about 8000" - and some still do, as that makes it the "youngest" in Victoria, which is important for tourism!!.

More recently a new age has been derived from the Harman Valley flow which comes from Mt Napier. Stone & others (1997) analysed the surface rocks of the lava flow at the Byaduk Caves for cosmogenic chlorine isotopes. These isotopes are formed when cosmic rays hit the surface of the rock. The longer the exposure to the radiation the more of these isotopes are accumulated. The calibration of the process is still being refined, but the estimated age of 32,000 years should be within a couple of thousand of the true age of the flow.

Tower Hill (about 35,000 years).

Again, the initial (minimum) age estimates from lake deposits (6000 - 7000 BP) are now seen to have been too young. In 1989, D'Costa & others reported new (but still minimum) radiocarbon dates from the lake sediments that suggest that volcanic activity was complete before about 21,000 years ago. Sherwood & others (2004) reported an older (minimum) date from the base of the crater sediments and also dated sediments underlying the ash deposits from the eruption (therefor giving a maximum age for the eruption) that indicates that the volcano is about 35,000 years old.

Mount Rouse (about 350,000 years).

At Mt. Rouse itself, Ollier (1985) reported a K/Ar date of 1.8 million years from a basalt flow interbedded with the scoria of the cone. Unfortunately, the 1.8 million age conflicts with significantly younger ages from the southern end of the Mt Rouse lava flow near Port Fairy where McDougall & Gill (1975) report several K/Ar dates ranging between 301,000 and 438,000 years. These were supported by a U/Th date on underlying (i.e. older) sediments of 400,000 (Gill & Amin, 1975) and also by more recently reported dates of 320,000 and 350,000 from a lava flow 20 km south of the volcano (Sutalo & Joyce, 2004). Thus, a round figure of 350,000 years old now seems suitable for Mt Rouse.

Portland area (about 3 million years)

The volcanics at Cape Grant have been dated by K/Ar at between 2.8 and 3.0 million years (Aziz-ur-Rahman & McDougall, 1972). The Volcano of Cape Bridgewater, a cross-section of which is exposed in the cliffs of Bridgewater Bay, has not been directly dated but might be of a similar age.

Older volcanoes and flows.

The western part of the volcanic province seems to have mainly formed by continual but intermittent volcanism spread over the last 5 million years. The oldest lavas are now deeply weathered to form thick clay soils (as around Hamilton), and the earliest volcanoes are so eroded that they are difficult to recognise. Mounts Baimbridge and Pierrepoint probably date from middle of that period as they are significantly eroded, but still recognisable. There is a K/Ar date of 4.35 million years from basalt in the Grange Burn west of Hamilton, and one of 3.91 million from near Lake Linlithgow, but neither of those can be tied to a recognisable volcano - unless the Lake Linlithgow flow came from Mt. Pierrepoint, as has been suggested by Rosengren (1994). A particularly old date comes from Lady Julia Percy Island, where K/Ar dates indicate an age of somewhere between 6.2 and 7.8 million years (Edwards & others, 2004).

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