**Lab protocol for10Be target preparation.**

Rock samples of the upper 5 cm of large size boulders were prepared for quartz isolation, chemically treated for precipitation of BeO, and loaded in cathodes at the University of Cincinnati 10Be geochronology lab. Rock samples were crushed, pulverized, and sieved into > 500 µm, 250 – 500 µm, and < 250 µm particle size fractions. The 250 – 500 µm fraction was used for subsequent quartz isolation and chemical preparation and the > 500 µm fraction was retained for further pulverizing, in the case that more sample was required. Samples were initially leached with an *Aqua Regia* solution (HCl/HNO3) for at least 24 hours to remove carbonates, phosphates, and organics. The samples were rinsed, dried and run through a Franz Isodynamic Magnetic Separator to remove magnetic and paramagnetic grains. After, the non-magnetic grains were leached twice, initially with a 5% followed by 1% solutions of HF/HNO3, each of them for approximately 24 hours on hot-rollers, aiming to remove meteoric 10Be and to dissolve other silicates. Then, density separation of quartz from feldspars and other heavy minerals grains was conducted in gravity separation funnels using a lithium heteropolytungstate (LST) solution with a density ~2.67 g/cm3. The grains differentiated as quartz, were then tested for impurities and their quality confirmed. The quartz grains were then chemical prepared to isolate the BeO. About ~15 to 20 grams of quartz were weighed and 9Be carrier was added (amounts reported in Table 6) before dissolution in concentrated HF and HNO3. After complete dissolution, the volume of the solution was reduced, and NaOH was added so that it would precipitate Fe and Ti and remove it from solution. An initial separation of cations Al and Be in solution is achieved through precipitation of Alluminium hydroxide gel and removal from the solution, promoted by favorable pH conditions obtained through a solution with HNO3 and NH4OH. The remaining solution is then run through cation exchange columns, to isolate Be from remaining Al and other cations, resulting in a BeOH gel. This gel is ignited at 750 °C for 20 minutes to obtain beryllium oxide (BeO2), which is then mixed with Niobium powder and loaded into steel cathodes for accelerator mass spectrometry at the Purdue University PRIME lab. Measured ratios of 10Be/9Be and subsequent ages reported were corrected based on a chemical blank prepared alongside the samples.

**Lab protocol for36Cl target preparation.**

Whole rock target preparation was performed at the University of Cincinnati 36Cl geochronology labs. A sledge hammer and rock saw were used to break surficial rock samples and then only the uppermost 5 cm from exposed surfaces of the boulders were considered for analysis. Samples were crushed, pulverized, and sieved into > 500 µm, 250 – 500 µm, and < 250 µm particle size fractions. The 250 – 500 µm fraction was used for subsequent chemical preparation and the > 500 µm fraction was retained for further pulverizing if more 250-500 µm sample was required. Approximately 100 g of the 250-500 µm fraction of the sample was leached using a 3% HNO3 trace metal grade (TMG) solution during 8 hours for three times and then decanted, rinsed with deionized water, and dried. Aliquots of approximately 10 g of the leached sample as well of the pre-leached sample were isolated and sent to Activation Laboratories Limited in Ancaster, Ontario, for geochemical analysis of major elements, uranium, thorium, and gamma emission spectrometry of boron and gadolinium. Chloride dilution spike carrier was added (amounts reported in Table 7) to approximately 30 g of the leached sample which is dissolved in a HF/ HNO3 TMG solution. After, AgNO3 is added to the solution so that AgCl is produced as a precipitate and then isolated. The precipitate is dissolved with NH4OH (TMG) and a solution of Ba(NO3)2 is added to remove sulfatesthat will precipitate as BaSO4. The Cl is then isolated by passing the solution through anion columns, and the drying for approximately eight hours at 65° C. The isolated Cl was loaded into copper cathodes for accelerator mass spectrometry at the Purdue University PRIME lab. Measured 36Cl/35Cl ratios and subsequent ages reported were corrected based on a blank and direct measurement of the chemical blank with 35Cl carrier prepared alongside the samples.