Student 2: High Merit
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Please note – This is an extract from one student's response

The Age of the Park Volcanics Group SE Southland.

The Event:

Shallow intrusive rocks with some extrusive rocks make up the Park Volcanic Group in SE Southland. They exist in rocks of the Triassic-Jurassic age. They include andesites, dacites and some ignimbrite. The rocks are primarily andesites and suggest emplacement in a back arc setting near an island arc system to the east. The prominent hill near Pomahaka suggests a sill, a shallow intrusive event, but the top of the layer is never exposed. These rocks make up the only volcanic rocks exposed in the Southland Syncline which formed off the east coast of Australia when New Zealand was still part of Australia. These volcanic rocks have been dated as they give the youngest age of the Southland syncline.

Dating techniques for older rocks:

Dating of older rocks (about 200ma) requires techniques with a half-life of greater than 1 million years. This is to get the accuracy required. (1) Young dating techniques like ^{14}C are no use as the half-life of ^{14}C is only 5300 years and would all be gone before 100 000 years is up. Key methods are described below.

Potassium-Argon Dating

K-Ar dating is based on measurement of the product of the radioactive decay of an isotope of potassium (K), which is a common element found in many materials, such as micas, clay minerals, tephra, and evaporites, into argon. The decay product ^{40}Ar starts to accumulate when the rock solidifies (re-crystallises). Time since re-crystallization is calculated by measuring the ratio of the amount of ^{40}Ar accumulated to the amount of ^{40}K remaining. The long half-life of ^{40}K allows the method to be used to calculate the absolute age of samples. This is an accurate measure but the sample must be divided into two and each analysed separately. (1)

Argon-Argon Dating

Argon-argon (or $^{40}Ar/^{39}Ar$) dating is a radiometric dating method invented to supersede potassium-argon (K-Ar) dating in accuracy. This technique differs from the K-Ar technique in that prior to measurement in a mass spectrometer, the sample is irradiated with neutrons in a nuclear reactor and some of the ^{39}K (present as a known fraction of the total K in the rock) is converted to ^{39}Ar. The ratio of the radiogenic daughter product, $^{40}Ar^*$, to ^{39}Ar (as a proxy for ^{40}K) can be measured in the same sample. $^{40}Ar^*$ has a short half-life (269 years) so any

present in the rock would be negligible and hence all $^{40}Ar^*$ is produced from ^{40}K.The half-life of ^{40}K is $1.248*10^9$ (1)

Rubidium-Strontium Dating

The rubidium-strontium dating method is a radiometric-dating technique to determine the age of rocks. The utility of the rubidium-strontium isotope system results from the fact that ^{87}Rb decays to ^{87}Sr. This method is useful for igneous rocks (1)

Uranium-Lead Dating

Uranium-lead is one of the oldest and most refined radiometric dating schemes, with a routine age range of about 1 million years to over 4.5 billion years, and with routine precisions in the 0.1-1 percent range. The method relies on two separate decay routes, from ^{238}U to ^{206}Pb and ^{235}U to ^{207}Pb. These decay routes occur via a series of alpha (and beta) decays. (1)

Cross correlation of the techniques to give the final age of the Park Volcanics.

The Park Volcanic rocks have been dated using three techniques used above. They have been dated as set out below.

Technique	Age (ma)	Error
^{40}K-^{40}Ar	206	+/- 2.5ma
$^{40}Ar^*$-^{39}Ar	199.6	+/- 0.8ma
^{87}Rb-^{87}Sr	197.5	+/- 2.2ma

These three dates state that the rocks are 199.6ma.