

Measuring U-Pb zircon ages in the Bear Island granodiorite

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Abstract

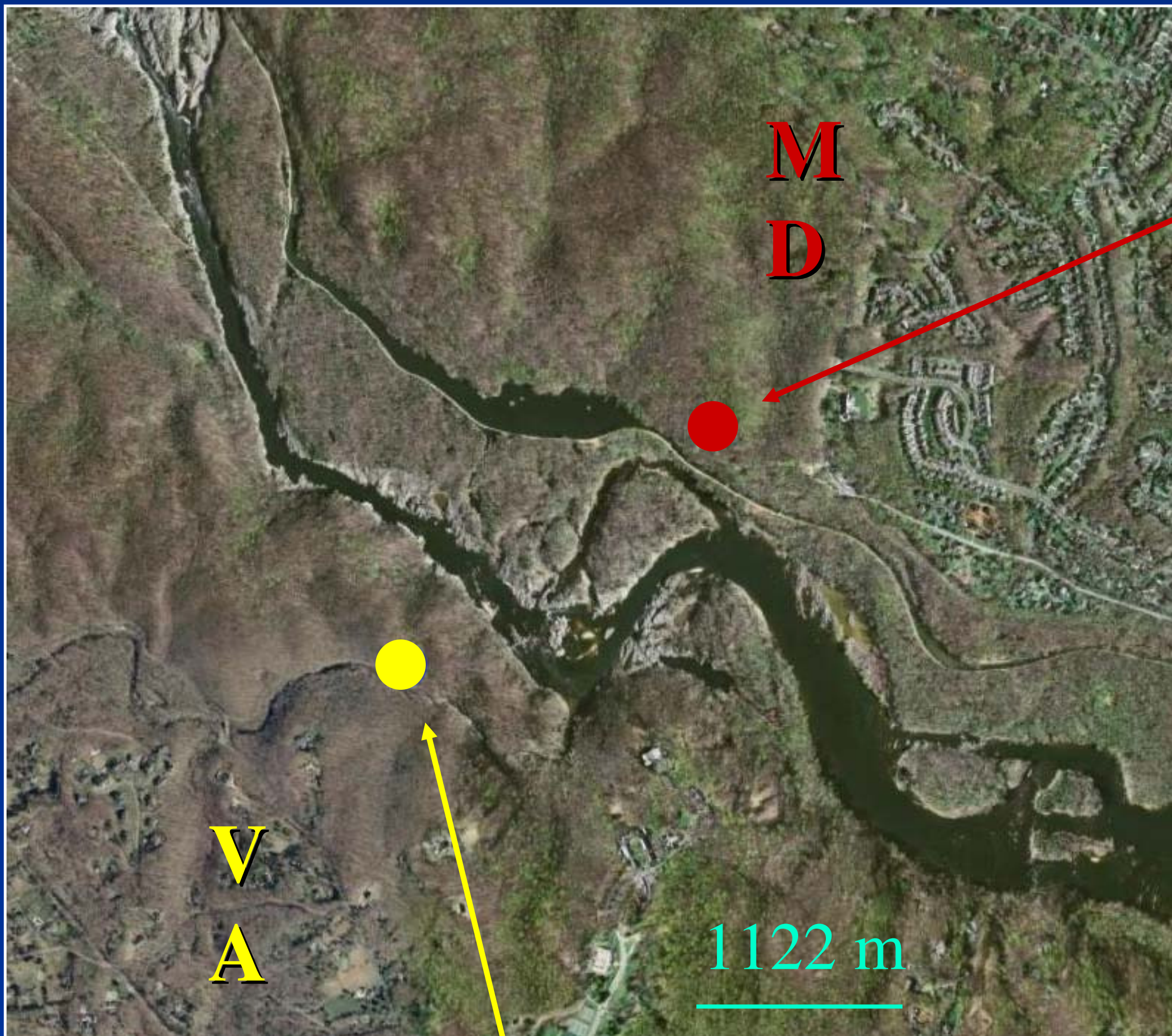
The Bear Island granodiorite outcrops at several sites within the ~50 km² migmatitic Bear Island domain of the Central Appalachian Piedmont. Samples collected from both Virginia and Maryland outcrops were processed using standard mineral separation techniques in order to extract and ultimately date zircons by U-Pb methods. Both cathodoluminescence imaging and laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) analyses were performed at the University of Maryland. Ages correlating to igneous crystallization were obtained by performing spot analyses on grain margins along what were interpreted to be magmatic growth zones. Unfortunately, only one grain produced an age of 571.1 Ma ± 37.4 (2σ), corresponding to magmatic crystallization associated with early Appalachian orogenic events. Remaining calculated ages for the Virginia sample (BIG-VA) produced a mean age of approximately 1200 Ma, implying that inherited zircon material was primarily analyzed and not magmatic growth zones. Additionally, complications due to low ion counts by the mass spectrometer resulted in unusable data for the Maryland sample (BIG-MD).

Problem

What is the crystallization age of the Bear Island granodiorite?

Hypothesis

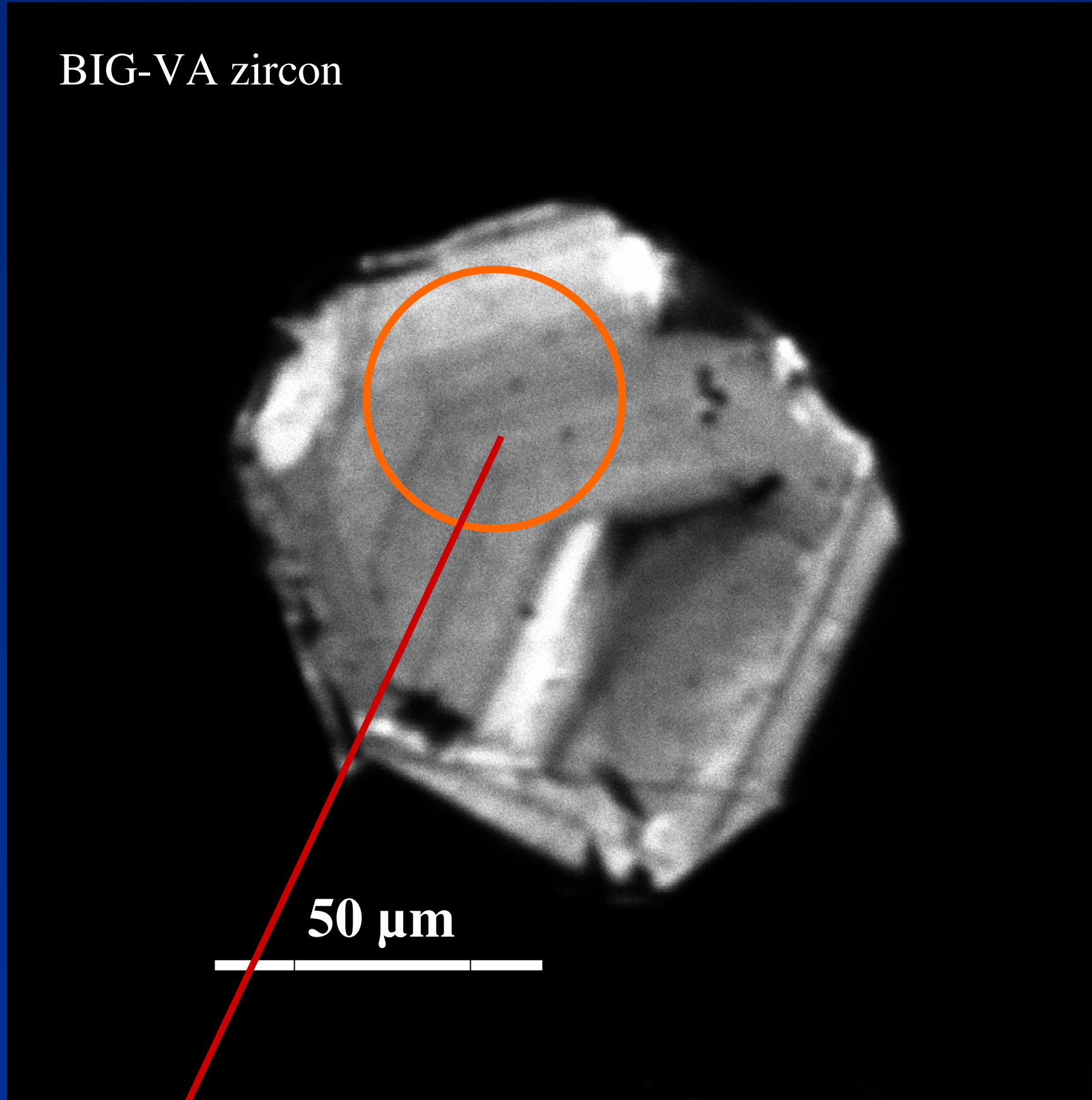
The crystallization age of the Bear Island granodiorite is approximately 500 Ma, corresponding to early Appalachian orogenic events and emplacement of other regional igneous bodies.



Intrusion of the Bear Island granodiorite in migmatitic schist of the Mather Gorge formation. Located ~500 meters east of Difficult Run parking lot, along creek.



Intrusion of the Bear Island granodiorite in metasedimentary units of the Mather Gorge formation. Located ~100 meters west of kayak parking lot, near Old Anglers Inn.



Cathodoluminescence image of youngest zircon, taken on a JXA-8900 electron probe micro-analyzer. Approximate size and placement of 40 μm laser spot shown.

571.1 Ma ± 37.4 (2σ)

Laser Parameters	BIG-VA	BIG-MD
Repetition rate	10 Hz	10 Hz
Power	54%	54%
Energy density	2.23 J/cm ²	2.23 J/cm ²
Spot diameters	30 μm, 40 μm	15 μm, 30 μm

Error Calculation

Instrumental mass discrimination:

NIST 612 glass standard used to tune mass spectrometer prior to session, enabling mass discrimination between the Pb-Pb, Pb-U, and Pb-Th isotopes

Elemental fractionation:

Fractionation factors determined from Harvard Standard 91500

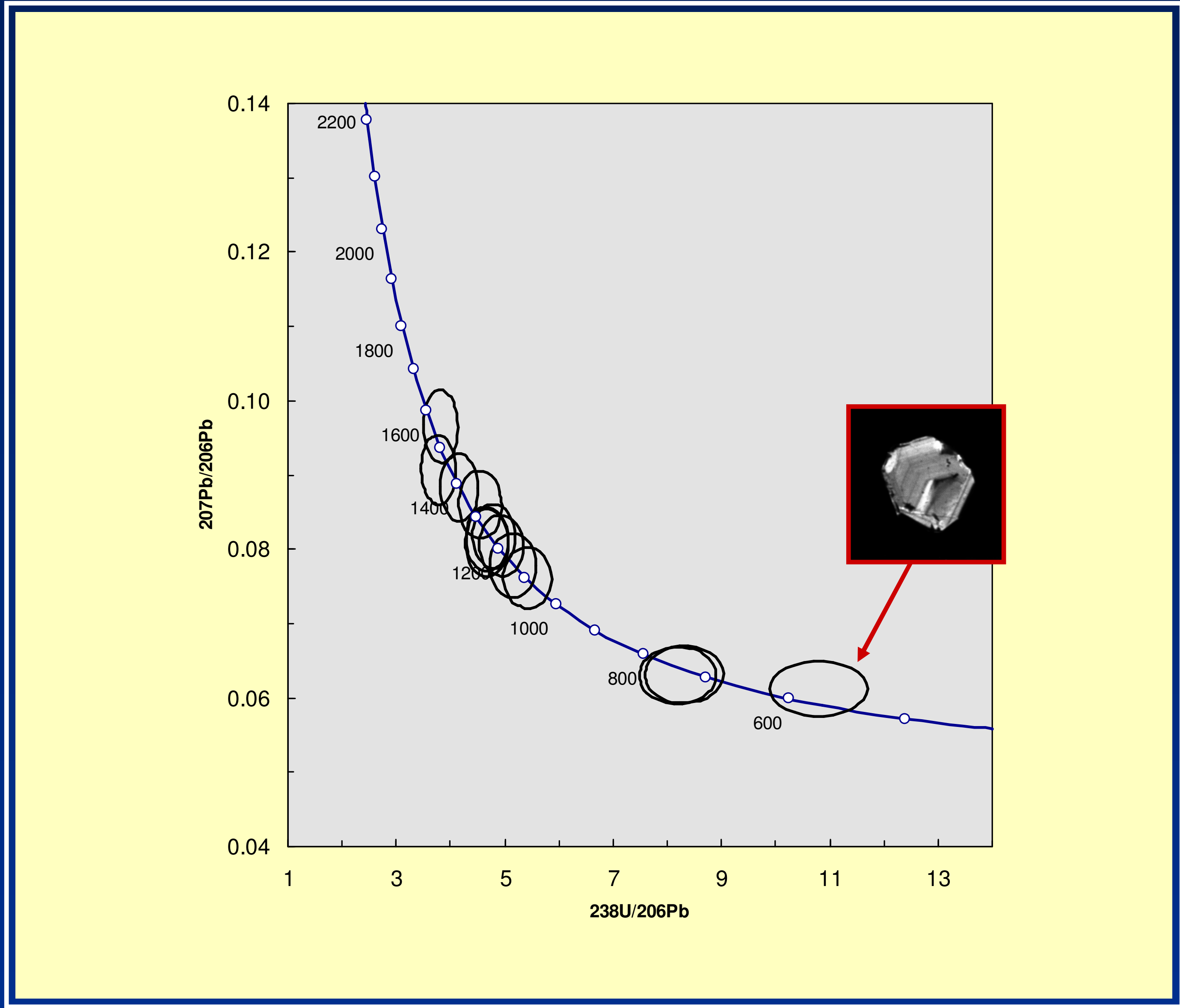
²⁰⁷ Pb/ ²³⁵ U	% 1 STDEV	²⁰⁶ Pb/ ²³⁸ U	% 1 STDEV	²⁰⁷ Pb/ ²⁰⁶ Pb	% 1 STDEV
1.306120	4.5	1.299245	4.3	1.004985	2.0

Common Pb:

First, ²⁰²Hg and ²⁰⁴(Pb + Hg) masses measured in order to calculate ²⁰⁴Hg blank corrected value

Next, by comparison with the natural ²⁰²Hg/²⁰⁴Hg, the blank corrected ²⁰⁴Hg value was calculated

Finally, ²⁰⁴Hg value was subtracted from the ²⁰⁴(Pb + Hg) in order to determine ²⁰⁴Pb



Concordance plot of zircon analyses from BIG-VA. Discordant points removed.

Summary of AVG Isotopic Ratios and AVG Calculated Ages

²⁰⁷ Pb/ ²³⁵ U intercept	2 σ abs err	²⁰⁶ Pb/ ²³⁸ U intercept	2 σ abs err	²⁰⁷ Pb/ ²⁰⁶ Pb intercept	2 σ abs err
2.407840	0.199801	0.205313	0.014173	0.083304	0.003744

²⁰⁷ Pb/ ²³⁵ U AGE	2 σ abs err	²⁰⁶ Pb/ ²³⁸ U AGE	2 σ abs err	²⁰⁷ Pb/ ²⁰⁶ Pb AGE	2 σ abs err
1221.8 Ma	57.5	1200.2 Ma	75.2	1257.8 Ma	86.9

Conclusions

The calculated ²⁰⁶Pb/²³⁸U age determined for the single BIG-VA zircon corresponds to crystallization of the Bear Island granodiorite during the Early Paleozoic. Intrusion of the granodiorite thus may have exceeded emplacement of other regional igneous bodies, which were determined by Aleinikoff et al. (2002) to be Ordovician or younger in age. This coincides with timing of the earliest Appalachian orogenic events, namely the Penobscottian orogeny. Furthermore, a minimum age of 571.1 Ma ± 37.4 may be applied to the deposition of the Mather Gorge formation protolith.

The above conclusions are based on the presumption that the age determined for this single zircon reflects the youngest crystallization ages of zircons found in the Bear Island granodiorite and that no inherited material was analyzed. Based on calculated ages for the majority of the analyzed zircon population, however, magmatic growth zones corresponding to the most recent crystallization events were not measured. Instead, the ages (avg. ~1200 Ma) are those of the inherited components. Further analysis of the Bear Island granodiorite must be completed before reliable crystallization ages can be agreed upon. Sensitive high resolution ion microprobe (SHRIMP) analysis is capable of avoiding inherited material, as pointed out by Aleinikoff et al. (2002), and thus may prove to be more successful than LA-ICP-MS.