**Student Exercise**

**“ZirChron” Virtual Zircon Analysis App**

**Access:**

Use a web browser (e.g. Safari, Chrome, Firefox) to access the app at:

[**http://www.boisestate.edu/earth-isotope/education-and-outreach/zirchron-virtual-zircon-analysis/**](http://www.boisestate.edu/earth-isotope/education-and-outreach/zirchron-virtual-zircon-analysis/)

Click on any photo banner to explore versions of the app for different types of rocks. You can ‘print’ the browser window to a pdf at any time to save a record of your experiments.

**Activity Learning Goal:**

This exercise is designed to help you evaluate a radioisotopic age and its uncertainty based upon the collection of data, the application of statistics, and the interpretation of geological and analytical sources of complexity and bias.

**Activity Learning Objectives:**

**By the end of this set of activities, students will be able to:**

* Describe the decisions that are made to determine the geologic age of a rock sample from a set of crystals
* Apply relative dating principles at the crystal scale
* Describe the statistical distribution of the crystal ages including means, modes and outliers
* Form hypotheses that relate the statistical distribution of crystal ages to the physical characteristics of those crystals
* Form hypotheses about the geologic and/or analytic processes that could account for the distribution of crystal ages in a population
* Explain the effect of increasing the number of analyses on the random uncertainties in age determinations
* Compare and contrast the LA-ICPMS and CA-IDTIMS analysis techniques with respect to precision and accuracy

**Activity #1: Probability**

**Select only 10 spots on the zircon crystals to analyze by laser ablation U-Pb analysis.**

**Questions to answer:**

1. What were your criteria for selecting your 10 spots?
2. What was the range of ages you measured in those spots?
3. What was the weighted mean age with uncertainty of your 10 spot analyses?
4. How would you describe the probability distribution of the spots you analyzed?
5. Is the probability distribution of your spots consistent with the model of a single age population as illustrated by the normal distribution?
6. Are there any correlations between numerical outliers or the shape of the probability distribution and the physical characteristics of the crystals?
7. Based upon this experiment, how would you change your strategy for determining the most accurate age of the zircon population?

**Activity #2: Reproducibility**

**Clear your selections, and then select only 10 spots on the zircon crystals to analyze by laser ablation U-Pb analysis with the goal of determining the most accurate age of the zircon population.**

**Questions to answer:**

1. What were your criteria for selecting the new set of spots, and how do those criteria differ from the criteria you used in Actvity #1?
2. What was the weighted mean age with uncertainty of your new set of 10 spot analyses?
3. Where you successful in avoiding outliers?
4. Considering both of your experiments, what geologic or analytical processes could account for a range of ages in a zircon population, including outliers?

**Activity #3: Precision versus accuracy**

**Clear your selections (“Select None”) and then select 1, 4, 9, 16, and 25 spots, each time recording the weighted mean age and error in the table below. You may choose to exclude outliers as you select your spots.**

|  |  |  |
| --- | --- | --- |
| **# Spots** | **Age** | **Error** |
| 1 |   |   |
| 4 |   |   |
| 9 |   |   |
| 16 |   |   |
| 25 |   |   |

1. How does the *precision* in the weighted mean age of your spots change with the number of analyses?
2. Can you write a formula for this relationship?
3. How could you assess the *accuracy* of your calculated age for the zircon population?

**Activity #4: Comparing LA-ICPMS versus CA-ID-TIMS methods**

**Clear your selections, move to the CA-IDTIMS page of the app, and then select only 10 single zircons to analyze by CA-IDTIMS U-Pb analysis.**

**Questions to answer:**

1. Describe your criteria for the selection of single grains to analyze by CA-IDTIMS? How were these criteria informed by your LA-ICPMS analyses?
2. How would you describe the probability distribution of the spots you analyzed? How does it compare to your LA-ICPMS results?
3. Are there any correlations between the numerical outliers and the physical characteristics of the crystals? Are there correlations of numerical outliers between the two methods (LA-ICPMS and CA-IDTIMS)?
4. What was the weighted mean age with uncertainty you interpreted from your set of 10 grains? How does your CA-IDTIMS result compare to your LA-ICPMS result?
5. Compare and contrast the LA-ICPMS and CA-IDTIMS analysis techniques in terms of precision and accuracy.

**Wrap up questions:**

1. Compare relative dating techniques that you might use in the field (e.g. superposition, crosscutting relationships, and principle of inclusions) with techniques you used to describe the internal structures of individual crystals.
2. Describe and defend an experiment that you would undertake (including crystal selection criteria, analytical methods, numbers of analyses) to accurately determine the crystallization age of a rock from a sample of zircon crystals.
3. How has your thinking about geochronologic ages reported in the literature changed as a result of these activities?