

Oddo-Harkins rule of element abundances

To instructors

This is a simple exercise designed to:

1. Introduce students to the instrumentation.
2. Introduce students to setting up data tables and to produce simple graphs on a spreadsheet.
3. To teach from experience the nature of the Oddo-Harkins rule (odd atomic number elements tend to be less abundant than adjacent even number elements).

The exercise handout

This lab is designed in part to familiarize you with the ICP-MS instrument and with formatting tables, making graphs, and doing calculations on a spreadsheet. We will analyze several pre-prepared solutions. These data produced will be used to investigate the accuracy, limitations, and possible extensions of the Oddo-Harkins rule.

Sample preparation (done before lab)

1. Prepare a 10 ppb solution of Sn and a blank in 1% HNO₃.
2. Dissolve any common igneous rock (e.g., a basalt or diorite) or metamorphosed igneous rock using [fusion](#) or [acid](#) techniques. It does not matter for this exercise if zircons or other components are not completely dissolved. Dilute the sample as appropriate. Internal standards, standards, and blanks are not needed for this exercise.

Demonstrating the instrumentation

This will be your first introduction to the ICP-MS instrument. At this stage the idea will be to just see how the instrument works. Analyze the blank and the Sn solution by peak hopping over the mass range 111 to 125. Next, analyze the blank and rock solution by peak hopping over the lanthanide mass range 139 to 175. Notice how to read the printouts, and how data are extracted in spreadsheet-readable form by another method.

Working with the Sn data

1. Take the Sn and blank data and put them into two spreadsheet columns, labeled by sample and analyzed mass.
2. Subtract the blank values from the Sn sample values to derive the signal actually caused by Sn in solution.
3. Make a bar graph of the blank-subtracted values.
4. Does the Oddo-Harkins rule, as stated, have any bearing on the appearance of this bar graph of Sn isotope abundances?
5. Propose an extension of the Oddo-Harkins rule that would bear on isotope abundances?
6. Test this rule by looking up isotope abundances of several elements with more than two naturally occurring isotopes in the Handbook of Chemistry and Physics, or alternatively at the [Table of the Nuclides](#) web site.

Working with the lanthanide data

1. Take the lanthanide and blank data and put them into a spreadsheet, like that for Sn.
2. Subtract the blank.
3. Make a line graph of the blank-subtracted values.
4. Does the Oddo-Harkins rule, as originally stated, have any bearing on the appearance of this line graph of lanthanide mass abundances?

Lanthanide crustal abundances

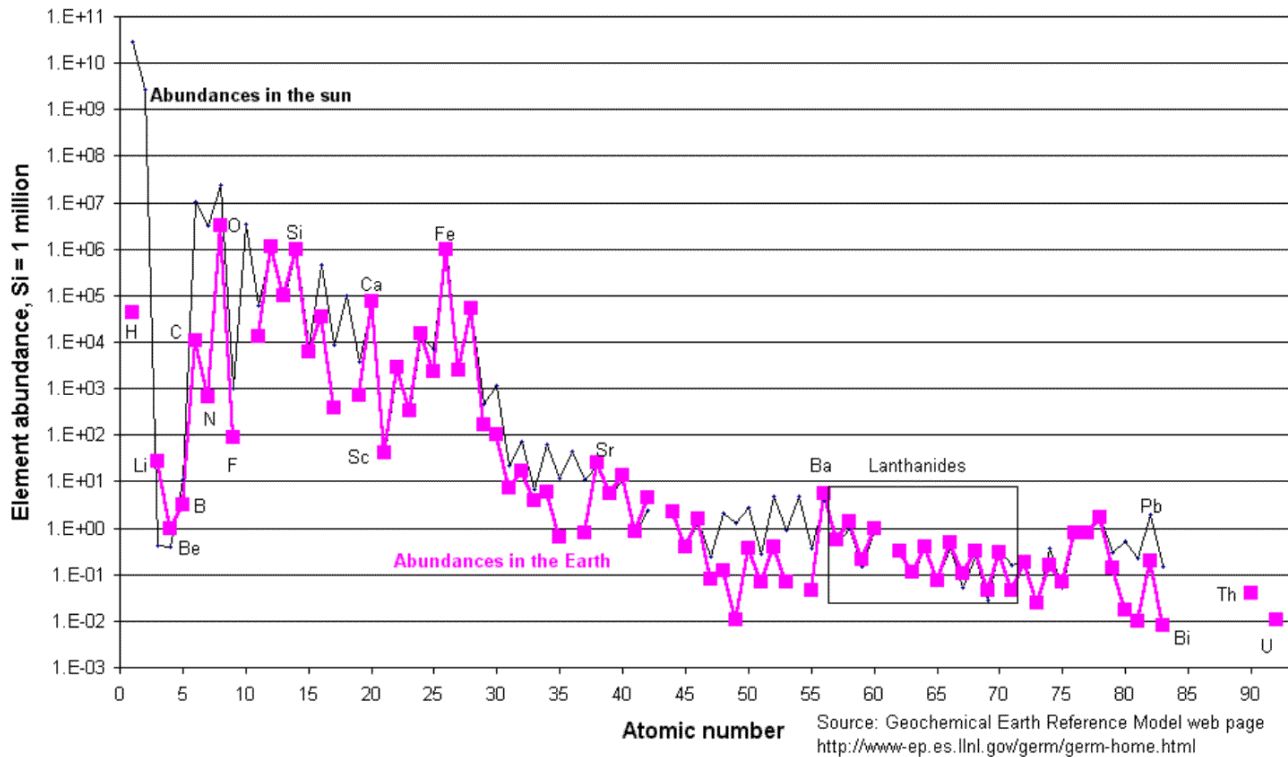
1. Find the relative lanthanide element abundances in the Earth's oceanic crust (these can come from a table in your text, or from the [Pacer](#) web page which can be downloaded as an Excel table.
2. Get the abundance data for the lanthanides (La to Lu) into a spreadsheet table.
3. Make a properly labeled line graph showing all of the lanthanide abundance data and with properly scaled axes.
4. Identify on the graph which lanthanide elements have even atomic numbers and which have odd numbers.
5. Does the Oddo-Harkins rule, as originally stated, have any bearing on the appearance of this line graph of lanthanide element abundances?
6. Prepare another, similar graph with all elements H to U. Show on this graph the ranges of elements produced by the E, R, and S processes. How does the Oddo-Harkins rule apply more broadly to the whole range of elements?

What is to turn in

1. Four graphs: tin isotopes, rock isotopes, lanthanide crustal abundances, all element crustal abundances.
2. A caption for each of the graphs.
3. Discuss the Oddo-Harkins rule with respect to the relevance of each of the four graphs.

Example of an element abundance graph for all elements for which data were available, comparing sun and carbonaceous chondrite meteorite abundances.

Element Abundances, Earth Compared to the Sun



Notes

Things needed for this lab

- High-purity HNO_3 .
- 100 ml volumetric flasks.
- Materials to do the rock dissolution (see dissolution procedures).
- Pipettes.
- 1000 ppm Sn standard solution.
- An igneous rock sample (a shale or slate would do fine also).
- Autosampler test tubes.

[Instrumentation lab exercises](#)
[Pedagogy web page](#)

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