The K and Th concentration in the Martian crust: insights from multi-scale analyses

David Baratoux[1], Fall Makhoudia[2], Pierre-Yves Meslin[3], Papa Moussa Ndiaye[2], Lenka Baratoux[4], Jean-François Moyen[5], Mark Jessell[6], and Olivier Vanderhaeghe[7]

[1]Université Félix Houphouët-Boigny
[2]University Cheikh Anta Diop
[3]IRAP, Universite Paul Sabatier
[4]IRD Institute for Research and Development
[5]University of Saint-Etienne
[6]The University of Western Australia
[7]Geosciences Environnement Toulouse

November 23, 2022

Abstract

The univariate statistics of potassium (K) and thorium (Th) concentrations in the oceanic and continental crust of the Earth has been recently investigated from geochemical databases and airborne radiometric surveys [1]. This study demonstrates that the frequency distributions of these elements are scale-dependent. There are right-skewed for small-scale samples (typical volume of rocks analyzed for an individual sample in a dataset) but tend to be more symmetric for large-scale samples. The right-skewed behavior of K and Th is attributed to their incompatible behavior during partial melting or fractional crystallization. The scale-dependence and evolution toward normal distributions are a direct consequence of the central limit theorem applied to K and Th concentrations. The results of the results of this study may be applied to Mars, using the Mars Odyssey global maps of K and Th concentrations [2]. In light of available K, Th concentrations at the rock-scale (in-situ samples and martian meteorites), we infer that each "pixel" of these maps reflect a right-skewed distribution of K and Th concentrations at smaller-scales, where K and Th-poor rocks, such as basalts, are spatially dominant. In turn, K, and Th-rich rocks, such as those found by Curiosity at Gale crater [3], may occur globally, though their spatial extension must be limited to account for the values reported by Mars Odyssey. The global, but sparse occurrence of K, Th-rich rocks at the surface is consistent with a buried felsic crust, outcropping at the favor of tectonic or impact events. These conclusions will be discussed in the context of the inferred constraints about the structure of the martian crust from Insight data [4]. [1] Baratoux, et al., Earth and Space Science, in press. [2] Boynton et al. JRGP, doi:10.1029/2007JE002887. [3] Sautter et al. doi:10.1038/NGEO2474. [4] Knapmeyer-Endrun et al., Science, doi: 10.1126/science.abf8966

Your Abstract Submission Has Been Received

Click here to print this page now.

You have submitted the following abstract to AGU Fall Meeting 2021. Receipt of this notice does not guarantee that your submission was free of errors.

The K and Th concentration in the Martian crust: insights from multi-scale analyses

David Baratoux[1], Fall Makhoudia[2], Pierre-Yves Meslin[3], Papa Moussa Ndiaye[2], Lenka Baratoux[4], Jean-François Moyen[5], Mark Jessell[6] and Olivier Vanderhaeghe, (1)Université Félix Houphouët-Boigny, UFR Sciences de la Terre et des Ressources Minères, Abidjan, Côte D'ivoire, (2)University Cheikh Anta Diop, Department of Geosciences, Dakar, Senegal, (3)IRAP, Universite Paul Sabatier, Toulouse, France, (4)IRD Institute for Research and Development, GET, UR 234, Toulouse III University, Toulouse, France, (5)University of Saint-Etienne, Saint-Etienne, France, (6)The University of Western Australia, Centre for Exploration Targeting (School of Earth Sciences), Crawley, WA, Australia

Abstract Text:

The univariate statistics of potassium (K) and thorium (Th) concentrations in the oceanic and continental crust of the Earth has been recently investigated from geochemical databases and airborne radiometric surveys [1]. This study demonstrates that the frequency distributions of these elements are scale-dependent. There are right-skewed for small-scale samples (typical volume of rocks analyzed for an individual sample in a dataset) but tend to be more symmetric for large-scale samples. The right-skewed behavior of K and Th is attributed to their incompatible behavior during partial melting or fractional crystallization. The scale-dependence and evolution toward normal distributions are a direct consequence of the central limit theorem applied to K and Th concentrations. The results of the results of this study may be applied to Mars, using the Mars Odyssey global maps of K and Th concentrations [2]. In light of available K, Th concentrations at the rock-scale (in-situ samples and martian meteorites), we infer that each “pixel” of these maps reflect a right-skewed distribution of K and Th concentrations at smaller-scales, where K and Th-poor rocks, such as basalts, are spatially dominant. In turn, K, and Th-rich rocks, such as those found by Curiosity at Gale crater [3], may occur globally, though their spatial extension must be limited to account for the values reported by Mars Odyssey. The global, but sparse occurrence of K, Th-rich rocks at the surface is consistent with a buried felsic crust, outcropping at the favor of tectonic or impact events. These conclusions will be discussed in the context of the inferred constraints about the structure of the martian crust from Insight data [4].

[1] Baratoux, et al., Earth and Space Science, in press. [2] Boynton et al. JRGP, doi:10.1029/2007JE002887. [3] Sautter et al. doi:10.1038/NGEO2474. [4] Knapmeyer-Endrun et al., Science, doi: 10.1126/science.abf8966

Plain-Language Summary:
The global maps of potassium (K) and thorium (Th) achieved by the Mars Odyssey mission are revisited in light of recent results on the frequency distributions of K and Th in the terrestrial crust. We demonstrate that the frequency distributions of the concentrations of these elements are scale-dependent, and generally evolve from right-skewed distributions toward normal distributions for increasing sample sizes. Extrapolating these results to Mars imply that K-poor and Th-poor rocks are spatially dominant at the surface of Mars, whereas sparse, but global occurrences of K and Th-rich rocks are necessary to account for Mars Odyssey results. These space occurrence of K and Th-rich rocks may reflect the existence of a buried and more evolved component of the martian crust. These conclusions will be discussed in the context of the inferred constraints about the structure of the martian crust from Insight data.

Session Selection:
P016. Illuminating the martian rock cycle with regional geochemistry

Submitter's E-mail Address:
david.baratoux@ird.fr

Abstract Title:
The K and Th concentration in the Martian crust: insights from multi-scale analyses

Requested Presentation Type:
Assigned by Program Committee (oral, eLightning or poster discussion session)

Previously Published?:
No

AGU On-Demand:
Yes

Abstract Payment:
Paid (waived)

I do not want to be involved in the OSPA program as a judge (students will be able to opt-into the OSPA program in October).

First Presenting Author
Presenting Author

David Baratoux
Primary Email: david.baratoux@ird.fr

Affiliation(s):

Université Félix Houphouët-Boigny
UFR Sciences de la Terre et des Ressources Minères
Abidjan N/A (Côte D'ivoire)

Second Author

Fall Makhoudia
Primary Email: fallmakhoudia79@yahoo.fr

Affiliation(s):

University Cheikh Anta Diop
Department of Geosciences
Dakar (Senegal)

Third Author

Pierre-Yves Meslin
Primary Email: pmeslin@irap.omp.eu

Affiliation(s):

IRAP, Universite Paul Sabatier
Toulouse 31028 (France)

Fourth Author

Papa Moussa Ndiaye
Primary Email: ndiayepm2@yahoo.fr

Affiliation(s):

University Cheikh Anta Diop
Department of Geosciences
Dakar (Senegal)

Fifth Author

Lenka Baratoux
Primary Email: lenka.baratoux@gmail.com

Affiliation(s):

IRD Institute for Research and Development
GET, UR 234, Toulouse III University
Toulouse (France)

Sixth Author

Jean-François Moyen
Primary Email: jean.francois.moyen@univ-st-etienne.fr

Affiliation(s):

University of Saint-Etienne
Saint-Etienne (France)

Seventh Author

Mark Jessell
Primary Email: mark.jessell@uwa.edu.au

Affiliation(s):

The University of Western Australia
Centre for Exploration Targeting (School of Earth Sciences)
Crawley WA 6009 (Australia)

Eighth Author

Olivier Vanderhaeghe
Primary Email: olivier.vanderhaeghe@get.omp.eu

Affiliation(s):

If necessary, you can make changes to your abstract submission

To access your submission in the future, point your browser to: User Portal
Your Abstract ID# is: 836695.
Any changes that you make will be reflected instantly in what is seen by the reviewers.
After the abstract proposal is submitted, you are not required to go through all submission steps to make edits. For example, click the "Authors" step in the Abstract Submission Control Panel to edit the Authors and then click save or submit.
When you have completed your submission, you may close this browser window or submit another abstract proposal: Call for Abstracts.

Tell us what you think of the abstract submission process