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Interactive comment on "Bioavailable Soil and Rock Strontium Isotope Data from Israel" *by* Ian Moffat et al.

Ian Moffat et al.

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Reviewer Comment #1: I thank the authors for submitting and sharing new data which contributes to the increasing world database of Sr isotope data for many applications. The article overall is somewhat short but well written, and the data generation is well executed. However, in my opinion the discussion (and manuscript) could be strengthened in a number of ways: for example, by including the data in line 85 and 98, and/or by including the data from the literature in new combined maps and graphs.

Author Response: The authors thank the reviewer for their constructive feedback in their review of this manuscript. These general comments are addressed later in this document as they are repeated below. The length of the paper is comparable to other

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Discussion paper

data papers, but in an effort to strengthen the manuscript and discussion, strontium isotope ratios from the sediments of seven archaeological sites in Israel are discussed and plotted in addition to the soil and rock samples included in the original submission.

Reviewer Comment #2: Regarding the abstract: in the first line the surprising and rather concerning statement is made that bones and teeth are made of biogenic carbonate. Although animal and human bone and teeth have some carbonate (for most around 4%) the majority of bone and teeth is made of bio-apatite which is a calcium phosphate mineral and Sr exchanges with Ca in either the phosphate or minor carbonate.

Author Response: This has been corrected, thank you for pointing out this error.

Reviewer Comment #3: Regarding the sampling; it would help if the authors could clarify how soil and rock samples were taken at each site. Was it just a single soil and single rock sample at each site? Were replicate samples taken? If so, what was the variation at one soil/rock site? Was the soil sample a composite of a square meter or something else? This is important in relation to the spread of values observed in figure 4 to determine if the observed variation is very local or characteristic for a whole lithology. The choice of sampling sites is also not properly explained. Is this to fill in gaps from the literature or are the sites chosen for representative lithology or convenience? The maps would benefit from showing the locations of previous literature sampling points. What is also missing is a description of the mineralogy of at least the rock samples, and evidence that confirms that the collected rock samples match the expectation from the lithological map mentioned.

Author Response: Thank you for your comment, this has been clarified in the text and answered below. A single rock and soil sample was taken at each site, with no replicates and the soil sample taken from a single point with no attempt to average the sample over a large area. Sample locations were chosen opportunistically to provide the greatest representation of the stratigraphic units present in Israel that were easily accessible via roads. Soil samples were collected from the topsoil and no attempt was made to sample multiple soil horizons when they were present, other than in archaeological sites where multiple stratigraphic units were samples where possible. We attempted to collect samples from undisturbed areas where there was an obvious spatial relationship between the soil and bedrock however cannot guarantee that these sites were free of anthropogenic contamination. No samples were collected in parks or nature reserves. The lithology of the rock samples and a brief description was recorded in the field, these are included in our data file as "Geology Observed in the Field" and "Geology Description from Field". We have not analysed the mineralogy of the rock or plant samples beyond what was described in the field. We agree that a combined map of all bioavailable strontium isotope analysis undertaken in Israel would be useful however the purpose of this paper was to share the data that we have collected. Further, the various other studies contain some inconsistencies in reporting their sample locations which make it challenging to integrate these data sets with ours.

Reviewer Comment #4: Regarding the results: when reporting scientific results, one should always consider the number of significant figures. In the text it is not clear what the quoted uncertainties entail, presumably single standard deviations of a single measurement (although figure 4 mentions 2sd)? If so, proper reporting of the for example a value of 0.710199 ± 0.000034 should be as 0.71020 ± 0.00003. The reporting of extremely “precise” numbers for Sr isotopes in soil samples suggest very well constraint values in the field, but proper analyses of replicates mostly shows the real variation in the field to be in the 3rd decimal of Sr isotopes. This is extremely important in forensic applications as to over-estimate precision (and accuracy) might lead to wrongful conclusions.

Author Response: Significant figures have been corrected throughout the text and figures. The errors reported are 2sd, from the measurement only as a single sample was collected at each site.

Reviewer Comment #5: Line 98: mentions that also elemental analysis was performed.

Why has that data not been used in the discussion of the data? It might elucidate important processes like the mentioned influences of seaspray and dust? Same for data mentioned in line 85. Using this data like the pH would probably strengthen the discussion.

Author Response: This comment refers to the soil colour and pH (line 85) and Sr concentration and elemental analysis. Strontium concentrations measured using ICP-OES and used to optimise our column chemistry and soil observations recorded in the field (grain size, sorting, colour, pH) have been added to the data files available online. The pH data for the soils is very uniform, ranging from 7.5 to 9.5 (although most samples are 8-9) for all samples, so has not been explored further in the text. Strontium was the only element measured, so we have removed mention that other elements were also analysed.

Reviewer Comment #6: Line 110: It is custom to mention the value of SRM987 during the measurement period and explain if any normalization was applied?

Author Response: During the analysis period, SRM987 ranged from 0.71012 ± 0.00001 to 0.71028 ± 0.00001, with a mean of 0.71022 ± 0.00003 (n=32). No normalisation was applied to the data using these data. This information has been added to the text.

Reviewer Comment #7: Line 117: Figure 3 does not really show statistical "correlations" with lithology. The graph assumes a high familiarity of the reader with Sr isotope systematics, which is unfair on others, thus the text should explain why a trained isotope geochemist "sees" some confirmation of expectations related to lithology and/or geological age. Has whole rock/soil XRF analysis been performed on the samples? This would help to better define the lithology.

Author Response: Thank you for the comment, we have updated the introduction to clarify some of the expected 87Sr/86Sr ratios in different lithologies. We have also avoided use of the word 'correlation' where a statistical relationship is not being discussed. XRF was not performed as part of the analyses in this project and we have accepted the lithology presented on the relevant geological map for each sample location.

Reviewer Comment #8: Line 129: significant figures?

Author Response: Amended.

Reviewer Comment #9: Line 138: The text refers to “error”, but what error is meant here. As alluded to above there is a major difference between instrument or method error versus variation in the or a field. It would be very helpful to know what the variation was in either soil or rock at any of the sites. Previous work, using large amount of replicates within a lithology, (see Voerkelius et al) has shown that the variation of Sr isotope in a local lithology is much bigger than the analytical variation.

Author Response: A single sample was collected from each location, so these errors do not refer to variation in the field, this is instrument error.

Reviewer Comment #10: Line 140-148: Interesting mention of the variability of the dust input but how stable is the Sr isotope signal on an annual basis (food authentication of forensics) or on an archeological time scale? Would be interesting to get the authors opinion about that. In addition, it would be good to try to get a better hold on the reason behind the “offset”. The authors already mention seaspray and dust, but a third component could be irrigation, which in many parts of Israel is water from Yam Kinneret and piped around the country. Noting that water from Yam Kinneret has shown stable isotope fractionation of Sr isotopes (see literature DOI: 10.1016/j.gca.2017.07.026) so it could give an extra marker for irrigation water contribution. Noting that the authors bracketed their measurements on the Neptune with ample standards they might be able to recover 88Sr/86Sr data from the soil measurements. Worth a try!

Author Response: Further investigation of the influence of irrigation on strontium isotope ratios in Israel would be an outstanding addition to this research for future studies, but unfortunately is beyond the scope of this project.

Reviewer Comment #11: Line 155-185; please round the Sr isotope figures to max 4 decimals as due the limited sample numbers the present numbers are again over-representing the accuracy.

Author Response: The data from this study has all been revised to display 5 significant figures in response to a previous comment. The data in lines 155 to 185 is from other studies, as referenced, which was reported to 5 significant figures.

Reviewer Comment #12: Line 194-195: The conclusion statement that the dataset is "comprehensive" is debatable as only 40 sites were sampled (on average one sample per âĹij550km2), and the sampling map clearly show large gaps. But it is a good start and complements other work. In addition, it would be good to investigate more what is the reason for the "offset".

Author Response: The authors agree that this dataset represents an exploration into strontium isotope ratios across Israel, and future research could improve upon this data in several ways, including further investigation of the offset observed between soil and rock samples. This dataset, however, is far more comprehensive than other work that has previously been undertaken in the region, and so represents a significant contribution to this field. We have clarified this in the manuscript text.

Reviewer Comment #13: Figure 1 and 2: What is the rationale behind the cut of levels for the colors? Other authors have used "packages" or deciles. Maybe it would be beneficial to add sampling points from the other discussed literature sources? Why is a satellite image used and not the geological/lithological map of Israel, as that would relate more to the choice of sites?

Author Response: The colour intervals used were chosen using the Jenks natural breaks in ArcMap, which optimises the deviation within individual classes relative to those of other groups, but is perhaps not very intuitive for readers. This figure has been amended such that each colour corresponds to an equal interval. When plotted on the geological map, it is almost impossible to distinguish the sampling locations, and the colours denoting the 87Sr/86Sr ratio are very difficult to see. The satellite image was used for clarity with this data, and to hopefully make this figure accessible for a range of readers. The lithological map was not one that we had considered but would be a much better option for overlaying points, particularly for displaying the sampling locations and not the results - we have developed another map which overlays the sample locations on the lithological map. Attempts were made to integrate the sampling locations from previous studies, but very few provide coordinates of sampling locations, and those which do use a different coordinate system in each instance. Combining the data from all these studies would be an excellent next step for this research, but is beyond the scope of this data paper.

Reviewer Comment #14: Figure 3: please add “n” numbers of samples in each lithology. Is it really 2 for granite? If so the box and whisker is very tentative, probably too tentative to present. A box and whisker plot gives information about quartiles and one could argue that that at least âĹij7 observations would be a minimum to make any statements as such.

Author Response: Thank you for the comment. The individual sample points were added to what was originally a boxplot in the hope of clarifying the number of samples in each lithology, but the plot has now been amended to only show the points as the boxplots are not appropriate for the dataset, and so hopefully this figure is now clearer.

Reviewer Comment #15: Figure 4: errors bars not visible. What 2sd values were use? Instrument sd’s? or method sd’s.

Author Response: The error bars are very small for most samples, and have been plotted in this figure, but are obscured by the points due to the scale on the y axis used to display as much of the data as possible. ‘Part b’ of this figure has been amended to remove the high rhyolite rock sample from site IS047 as well as the elevated granite rock sample, which allows some of the error bars to be visible in this subset of the full data in Part a.

Reviewer Comment #16: Table 2: best to report only significant figures.

Author Response: Thank you, this has been amended.

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