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eEarth Discussions

Interactive comment on "Noble gas signature of the late heavy bombardment in the Earth's atmosphere" *by* B. Marty and A. Meibom

M. moreira (Referee)

moreira@ipgp.jussieu.fr

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The authors present an estimate of the mass of Kuiper-belt material that is required to explain the abundances of some volatile in Earth's atmosphere. They use their estimate of the water, N and rare gases abundances to constrain the proportion Kuiper-belt /asteroid-like material. They get a small proportion of volatile-rich material (0.5%), enough to bring some of these volatiles in the atmosphere, in particular Ar and Kr. This is an interesting approach although I see some problems in the interpretations that are sometimes clearly pushed in the Kuiper-belt material way without exploring other solutions. First of all, I have to say that there are clear problem of references. For exempla, forget Staudacher and Allegre, and Kunz et al. for the degassing of the xenon is a crime of lese Majesty that should be easily corrected in the final version of the paper. Secondly, the problem of normalization to C1 is critical when comparing water, N and rare gases. This should be better discussed in the paper. Thirdly, although they claim that Dauphas already discussed the problem of isotopic ratios, here, they do not have the same approach since they consider that all, or almost all, of the 36Ar and 84Kr in the Earth are deriving from Kuiper-belt objects to get their proportion of 0.5%. Therefore, the problem of isotopic ratios of the atmosphere versus the ones of the Kuiper-belt objects has to be discussed. These major comments are detailed below. Nevertheless, this is a very interesting paper that should be published with major corrections, including better discussion of the hypothesis and the consequences for isotopic ratios.

The problem of normalization

Using the normalization to C1 leads to the conclusion that rare gases are enriched compared to N and H2O. This depends strongly of the assumption that the parent bodies are the C1, which is not proven, and even probably wrong (cf oxygen isotopes). A different normalization (for exempla, enstatite, ...) could lead to a very different result. This has to be discussed. For exempla, using enstatite chondrites as the normalization will lead to a normalized H2O in Earth abundance much higher (x100) (Javoy, 1998) without changing the noble gas abundances (e.g. Patzer and Schultz, 2001). Therefore, using this normalization, rare gases are not in excess anymore.

Quid about isotopic ratios?

The origin of the atmosphere by comet-like material is classic, but had always suffered an opposition because of the isotopic ratios of the rare gases. One should expect solar noble gases in comets, which is not observed in Earth's atmosphere. I am conscious that the hypothesis that ice have solar isotopic compositions may be wrong, but I really think the authors should discuss that, in particular the case of the argon and krypton isotopes (are they a residue of evaporation (e.g.distillation)?). Since they match the Ar and Kr abundances of the bulk Earth with Kuiper-belt objects, they assume neces-

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sarily that all (or almost) the 36Ar and 84Kr derive from these objects (figure 3). The authors assume that Jupiter is formed by such material (page 105, line 20). However, measurements of Galileo probe show that neon and xenon isotopic ratios, as well as the 38Ar/36Ar ratio are solar in Jupiter (Atreya et al., 2003). One can also assume that the krypton isotopic ratios are solar. Since the authors assume that all the argon and krypton from the atmosphere is coming from Kuiper-belt objects, how can they reconcile the Jupiter measurements with the fact that krypton (and argon) isotopic ratios are not solar in the Earth's atmosphere (if hydrodynamic escape was before the LHB)?

What about water?

Do I understand from the paper (figure 3) that only ˜1% of the water is derived from the Kuiper-belt objects? This may require a sentence in the paper (it is coherent with the D/H, ...).

Minor comments

1.Page 101, line 29: may be they could precise "xenon systematics in mantle derived rocks".

2.Page 103, line 16: 20km3/year

3.Page 103, line 18: where does this number for 22Ne come from? It is much harder to get the 22Ne with the method of the fluxes. It is not clear.

4.Page 104, line 4: Another possibility is to assume that there is dilution (by a factor 1000 in mass) of material that contains less gas than C1.

5.Page 104, line 10: this assumes that all the mantle is degassed.

6.Page 104, line 17: Why N and H2O were not lost to space, leading the heavy elements enriched in the atmosphere compared to the N and water?

7.Give the units on the figures (y-axis)

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