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Nonlinear Processes in Geophysics
Discussions
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Interactive comment on "Multifractal analysis of mercury inclusions in quartz by X-ray computed tomography" *by* T. Shibata et al.

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Overall comments:

The paper is sound and interesting.

I would like to see the final inference strengthened: that based on the fractal dimension you see, you can make inferences about the processes by which they occurred. But that comment presumes that I have understood the overall story you're telling. So my main recommendation is that you tell the story (the geological sequence) more clearly, and earlier in the paper; with that in place, you can then make your conclusions clearer and stronger.

Also, you might then change the title to something like "Inferring origin of mercury

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intrusions in quartz by multifractal analysis"

Scientific issues:

The fractal dimension of the mercury inclusions is constrained by (1) the available pores (cracks, grain boundaries, bubbles, etc.) in the native rock, (2) any subsequent processes (diagenesis) that alter the rock pore space, and (3) the processes(es) by which the mercury moved into the pores. Presumably the size of the pores, and therefore the size of any individual inclusion is determined by (1) and (2), while the fractal distribution of mercury within the pores is determined by (3). But it would help the reader to “paint the picture” more clearly, in order to avoid confusion between (a) any fractal character of the pore space itself, and (b) the fractal distribution of the mercury. Perhaps a new short paragraph, just 2 or 3 sentences, at the end of the introduction, would make this point. (You give some of this information at 1371:15-21, but it would be more useful to say this earlier, and in more detail.)

If it is made clear that the fractal distribution of the inclusions must be due to how the mercury arrived, then the conclusions make more sense. If I understand your description correctly, the distribution is rather like a 3D version of Cantor dust, with individual inclusions clustered fractally. If this is correct, and made clearer, then your conclusions about how the mercury arrived can be made more strongly.

Regarding the actual process by which mercury arrived, there does seem to be some confusion. Is it a DLA process, or a percolation process? Or perhaps DLA on a percolation network? That 3rd possibility would have (1) and/or (2) above constrain the pattern given by (3), which would be interesting and worth noting. The difficulty you face is that fractals produced in nature are subject to additional influences, such that you can’t necessarily expect the theoretical dimension to come through precisely. Also, very different processes can result in similar fractal dimensions (I was involved years ago in a paper that faced a similar issue). And yet, the numbers definitely strongly point to DLA. I would like to see a little discussion of what *physical* DLA process

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would lead to this (apparently) DLA pattern. Also, from a porous media perspective, DLA often results from viscous fingering, while percolation-like patterns more likely come from capillary fingering. The two may have similar fractal dimensions, but they differ in rate; also, DLA results in a tree-like topology while capillary fingering can produce loops, so you may have additional information to help decide between these two options.

Presentation

Abstract:

1366:9 (Page 1366, line 9), “mines”: The point is not that the quartz comes from different mines, but rather that it comes from different geological formations. This comment also applies to other mentions of the word “mines”.

1366:10, “for the samples”: although this is still the abstract, you should be more exact about what precisely has this fractal dimension.

1366:12, “Then,”: change to (for example) “Given the fractal dimension and its implied mechanism, we conclude that ”

Body of paper:

1368:21-24: These sentences as written completely confused me for a while! They could be interpreted to mean that the inclusions are scale-free in terms of size: that the mercury inclusions occur in all sizes. But of course they don’t, or one would occasionally find massive inclusions. Rather, it is the *distribution* that you are examining. Also, the word “shape” (line 22) is misleading: it seems that you are talking about the shape of an individual inclusion, rather than the fractal character of the spatial distribution of the inclusions. I recommend changing the first “shape” on line 22 to “properties”, and deleting the second, giving: “intrusions have fractal and multifractal properties. Because a fractal typically has. . . distribution of the inclusions follows a power law. . .”

1369:20: insert the word “then”: from experiments, then the singularity. . .

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1371:10: delete the “D” after “three-dimensional systems. It is confusing and unnecessary!

1379 (Fig. 4): could you perhaps insert a dotted vertical line through q = 0, so the reader’s eye more readily appreciates the 1.7 on this plot?

English:

1367:21, “objective”: I am not sure what you mean by this word. Perhaps you mean “opaque” (materials you can’t see into with your own eyes)?

1368:19” insert “were”: inclusions were analyzed

1368:21: delete “that”: nature, and the spatial. But you might change it to “often”: common in nature, and often the spatial distributions. . .

1369:10, 1369:12, and 1370:5: delete “the” preceding “multifractal theory”

1372:13: change to “inclusions were ramified like a dendritic structure.”

1372:17: change to “We analyzed mercury intrusions”

1376 (Fig. 1 caption): change “binatized” to “binarized” (2 instances).

Interactive comment on Nonlin. Processes Geophys. Discuss., 1, 1365, 2014.