

Interactive comment on “Non-invasive diagnostics in pathological fossils by magnetic resonance imaging” by D. Mietchen et al.

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General Comments

The paper by Mietchen, Keupp, Manz and Volke describes a revolutionary use of MRI technology. Non-invasive techniques for the evaluation of pathologies in Mesozoic fossil material has, in the past, been restricted to CT scanning and 2D x-ray imaging. The use of MR imaging in solid mineralised fossil material is surprising considering the fact that the technology relies on the spin of NMR-friendly protons in a magnetic field. Where are these nuclei? Is it in intracrystalline, or intercrystalline, organic material trapped in the calcite skeletons, or is it an inorganic source? These options are discussed and preference seems to be, at least, for an organic source.

Specific Comments

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A useful comparative study would have been to examine the same structures using CT scanning to see if shell density produces a similar image to that produced using MR imaging. This may help in interpreting the source of the nuclei resulting in the interpolated image using MR. If a belemnite could be sacrificed to determine the organic content, water content, and composition, this may also be useful in determining the source nuclei.

One question that has been bothering me is whether the belemnites have undergone any conservation through preparation, in the past, that may have involved consolidants. In an abstract (McJury et al. 1994), when I was first starting out using MR imaging as a non-invasive technique to examine fossils, we described a response obtained from dinosaur egg shell. In our abstract we were at a loss to explain the origins of the mobile protons, but on reflection (and unpublished thoughts), the image may have been produced by consolidants used to glue the eggshell in place.

On p242 line 8, the authors state that the work by Clark et al. 2004 was 'destructive', however the whole premise of our article was that this was a non-invasive, non-destructive means of looking at moldic fossils rather than the standard palaeontological technique of filling the cavity with liquid rubber and breaking the rock open to reveal the cast, thereby destroying significant parts of the fossil.

The abstract is well structured although I don't like abstracts that use the term 'is discussed' without informing the reader of what the results of this discussion are. The rest of the article is well written and structured with minor grammatical errors, inconsistency of term use, and a few words that I would have used other terms for. If these issues are addressed to the editors satisfaction, I would support the publication of this paper as a valuable contribution to the development and promotion of non-destructive techniques in palaeontology.

McJury, M., Clark, N. D. L., Liston, J. and Condon, B. Dinosaur Egg Structure Investigated by MRI. Proceedings of the Society of Magnetic Resonance, 2nd Meeting. 1994.

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Technical corrections (Not all these corrections are necessary, some are just my own personal preference.)

p240, line 2: The term Magnetic Resonance Imaging should be used consistently throughout the paper. It may be easier to change all occurrences to 'MR imaging' rather than 'MRI' as I think the former is used more throughout the article than the latter*. p240, line 3: change '..allows to non-invasively study anatomical..' to '..allows non-invasive study of anatomical..' p240, line 5: change '..particularly in soft tissue..' to '..particularly of soft tissue..' p240, line 5: remove 'Here, we demonstrate that' p240, line 8: change '..putative paleopathological scenarios..' to '..putative paleopathologies..' p240, line 14-15: restructure or remove '..is being discussed..' perhaps just insert '..is great.' p240, line 22: change '..attack lead to..' to '..attack leads to..' p241, line 10-11: remove 'on the one hand' and 'on the other hand' p242, line 8: change '..and destructive..' to '..and non-destructive..' p242, line 16: remove '..(MRS)..' as it is not used elsewhere in the article p243-244, line 27-2: rewrite sentence starting 'Specimens of the latter' to 'Specimens of the latter group are collectively referred to as "pathological" (Keupp, 2002), especially in juveniles, and are the focus of this study.' p244, line 6-8: replace '..rostral fractures, rather than to an unsuccessful attack by a predator, to damage experienced when the animal used its posterior end as a digging tool.' to '..rostral fractures to damage experienced when the animal used its posterior end as a digging tool, rather than to an unsuccessful attack by a predator.' p244, line 11: replace '..attacks of predators..' by '..attacks by predators..' p244, line 22: remove '..of the..' p244, line 23: insert 'the' in '..rostrum from Toarcian..' to read '..rostrum from the Toarcian..' p245, line 22: replace '..from outside..' by '..externally..' p245, line 24-25: replace '..anomalies could non-invasively be extracted..' by '..anomalies could be extracted non-invasively..' p245, line 25: remove '.. Magnetic Resonance (MR)..' and replace with '..MR..' p246, line 6: replace '..fragment has ventrally been dislocated..' by '..fragment has been dislocated ventrally..' p246, line 13: replace '..as to represent a

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temporary..' by '..as representing a temporary..' p246, line 16: replace '..Particularly inside the knee-like arrangement of the rostral fragments (i.e. dorsally), the...' by replace '..Inside the knee-like arrangement of the rostral fragments (i.e. dorsally), in particular, the...' p246, line 17 and 19: replace '..posttraumatic..' with '..post-traumatic..' p246, line 19: replace '..knee..' by '..'knee'..' p247, line 9: insert 'been' in '..in part torn off..' to read '..in part been torn off..' p247, line 14: replace '..rostrum could evolve..' by '..rostrum could grow..' p247, line 17: insert ',' after 'phenomena' p247, line 18: insert ',' after 'centres' p248, line 1: insert ',' after 'guard' and 'damage' p248, line 3: replace '..inflammatory..' by '..inflamed..' p248, line 18: unsure of meaning here, perhaps replace '..drawing..' by '..around..'? p248, line 25: perhaps replace '..syndrome..' by '..pathology..'? p248, line 26: replace '..and - outside the anomaly - 7mm wide rostrum of..' by '..and 7mm wide rostrum, not including the anomaly, of..' p249, line 7: perhaps replace '..the (invisible) primordial rostrum..' by the unseen primordial rostrum..'? p249, line 10: replace '..irregular tissue without or with only slight..' by '..irregular tissue with, or without, only slight..' p249, line 13: replace '..Magnetic Resonance..' by '..MR..' p249, line 13-14: replace '..allow to non-invasively visualize structural details in fossils..' by '..allow non-invasive visualization of structural details in fossils..' or '..allow us to visualize structural details in fossils non-invasively..' p249, line 14: replace 'own fossils..' '..own, as fossils..' p249, line 15: insert ',' after 'soft tissue' p249, line 16: remove 'our feasibility proof of fossil MRI may be less striking than' p249, line 17: remove 'rock' p249, line 18: insert 'is striking.' or 'is significant.' after '..mineralized materials' p249, line 23: replace '..the syn-vivo processes laying the ground for the uneven signal distribution were activated rather than inactivated by the pathological incident.' by '..the in-vivo processes activated by the pathological incident, laid the ground for the uneven signal distribution.' or something similar p250, line 1: replace '..content might have been..' by '..content may have been..' p250, line 4: remove 'well' p250, line 5: remove 'basically' p250, line 5: replace '..content in organic matter..' by '..content of organic matter..' or is that '..content of inorganic matter..'? p250, line 7: replace '..anorganic..' by '..inorganic..' p250, line 9-10: replace '..hydrogen nuclei of crystal water in inorganic

materials can usually not be distinguished..' by '..hydrogen nuclei in structural water of inorganic materials can not usually be distinguished..' p250, line 13: insert 'future' before '..comparative..' p250, line 15: insert 'us' after '..allowed..' p250, line 15: replace '..observe their small-..' by observe the small-..' p250, line 22: replace '..opposite..' by '..reverse..' p250, line 26: replace 'anorganic' by 'inorganic' p250, line 28: replace 'configuations' by 'configurations'

*'MR imaging', 'MR' or variations should be used on the following pages instead of 'MRI' or 'Magnetic Resonance' (I may have missed a few): p 240, line 9; p 241, line 23; p 245, line 2; p 245, line 25; p249, line 13; p250, line 29

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