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Reply

Reply to the Comment on the paper on natromelansonite by Gore and McDonald (2024)

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The question of Al content and distribution

The content of Al is 6.86 wt.% Al_2O_3 (average of 8 analyses; Lykova *et al.*, 2024) in natromelansonite and 6.29 wt.% Al_2O_3 (average of 8 analyses; Lykova *et al.*, 2024 [note there is a typo in Lykova *et al.*, 2024: 5.89 instead of 6.89; so the correct range is 5.53–6.89] and 6.32 wt.% Al_2O_3 (average of 15 analyses; Gore and McDonald, 2023) in melansonite. These numbers are very consistent and correspond to ~1 atoms per formula unit of Al.

In the structures of both melansonite and natromelansonite one of the Si-centred tetrahedra is larger than others which is reflected in lower bond-valence sums for one of the Si sites in both melansonite (Si3, 3.63 vu; Gore and McDonald, 2023) and natromelansonite (Si4, 3.65 vu; Lykova *et al.*, 2024).

These data are consistent with our model of ordering of Al atoms at one of the Si sites and support the $Y^{3+} + Si^{4+} \leftrightarrow Zr^{4+} + Al^{3+}$ substitution mechanism to describe the relationships between melansonite/natromelansonite and monteregianite-(Y). Such ordering has also been described in the other members of the rhodesite mero-plesiotype series: delhayelite, hydrodelhayelite (Pekov *et al.*, 2009) and fivegite (Pekov *et al.*, 2011).

The model supported by Gore and McDonald does not predict these data nor do they provide an alternative explanation for it. Furthermore, U-rich melansonite that Gore and McDonald used to illustrate variability of Al content in melansonite (4.21 wt.% Al_2O_3; Lykova *et al.*, 2024) is, in fact, a *Ln*-rich phase, which corroborates with the $Y^{3+} + Si^{4+} \leftrightarrow Zr^{4+} + Al^{3+}$ substitution mechanism.

Na in the structure of melansonite

Gore and McDonald did not provide the refined occupancy factor for the partially-occupied Na site in melansonite in either the original publication (Gore and McDonald, 2023) or the Comment (Gore and McDonald, 2024). Furthermore, they stated that the occupancy at the site was fixed to satisfy the charge balance by the substitution mechanism $Y^{3+} + Na^{+} \leftrightarrow Zr^{4+} + \square$. Thus, the number was fixed to fit their model; therefore, it cannot be used to test either of the models.

Conclusion

Based on the available data, Al should be considered a species-defining element in both natromelansonite and melansonite. The model based on the $Y^{3+} + Na^{+} \leftrightarrow Zr^{4+} + \square$ substitution mechanism does not predict the observed phases or the existing data. A new model or/and new data is required to challenge our interpretation of natromelansonite and melansonite.

Competing interests. The author declares none. Note: This response is from I. Lykova, there were additional co-authors on the original manuscript.

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