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Letter

Discovery of an Earthborn quasicrystal approximant

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Abstract

Natural quasicrystals, compounds with characteristics intermediate between crystalline material and glass, have been so far discovered in extraterrestrial materials only. Furthermore, their occurrence in nature is limited to metallic, Al-bearing alloys. The presence of metallic aluminum in these minerals raised doubts about their potential occurrence in terrestrial rocks. The geochemical conditions needed to form metallic Al are so reducing that they are considered very unlikely in a terrestrial environment. Given the report of dodecagonal symmetry in the synthetic $Ta_{1.6}Te$ quasicrystal, the search for terrestrial quasicrystals was focused on natural tellurides.

Here, we report the discovery of the first terrestrial approximant of a dodecagonal quasicrystal, a Pd-Ni-telluride with formula $Pd_3Ni_4Te_8$ and tetragonal symmetry, which was found as small inclusions in a rock sample from Kalgoorlie, Western Australia. Periodic approximants are crystalline materials that share a similar chemical composition with quasicrystals but have a slightly altered atomic structure, aligning their symmetry with the traditional principles of three-dimensional crystallography. These crystalline approximants provide insights into the local atomic structure of their corresponding quasicrystals.

Natural $Pd_3Ni_4Te_8$ has been approved as a new mineral by the International Mineralogical Association with the name proxitwelvefoldite (IMA 2024-034). The $Pd_3Ni_4Te_8$ composition has never been reported to form quasicrystal approximants among synthetic products and could indicate the possible existence of a 12-fold quasicrystal in the Pd-Ni-Te system. The discovery points to the possibility that the quasicrystalline structure may be much more common than previously thought, even in non-alloy systems.

Keywords: Quasicrystal, approximant, Earth, new mineral, Pd-Ni-Te system, crystal structure