

尖晶石類新礦物執明石說明稿

緣由：

2022年是聯合國教科文組織(United Nations Educational, Scientific and Cultural Organization,簡稱UNESCO)和國際礦物學協會(International Mineralogical Association簡稱IMA)在區域、國家與國際間共同推動的國際礦物學年，附屬國際可持續發展基礎科學年，強調礦物學對於基礎科學的重要性。值此具有基礎科學深意的2022國際礦物學年，本研究團隊有幸分享在挪威發現而且經過國際礦物學協會嚴格認證的尖晶石類新礦物執明石(IMA於2022年五月二日投票通過CHIHMINGITE 2022-010此案)，特別請最資深的朱倣祖代表國內外共同作者介紹其產狀、成份、結晶構造與若干物理性質(請參考本次台灣地球科學聯合學術研討會PP-GS-V-003摘要或是第3-4頁節錄)。

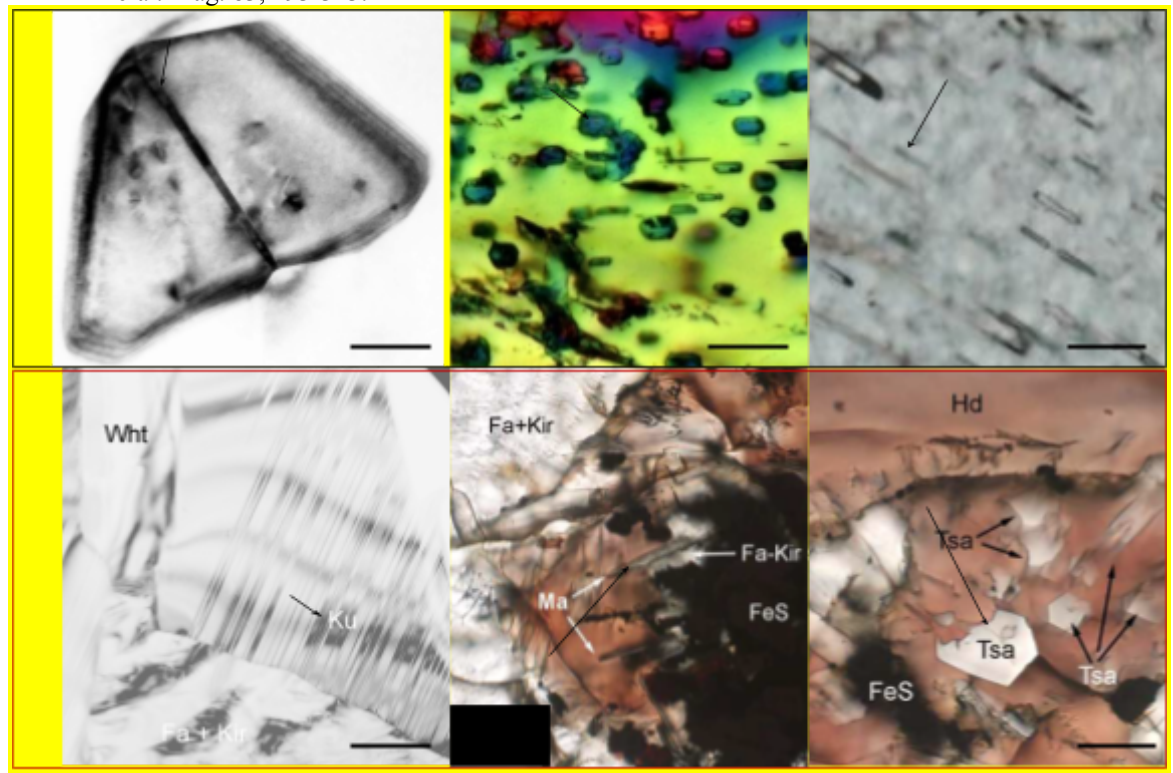
尖晶石類新礦物執明石 本事

尖晶石類氧化礦物 AB_2O_4 (A與B分別為正二價與正三價金屬離子)種類繁多，常見於海洋地殼底部與陸上火成、變質、沉積岩之中，鉻鐵礦、磁鐵礦、大紅寶石均屬此類，也是耐火結構與功能陶瓷發展的藉鏡。這次於挪威威默勒-魯姆斯達爾郡莫爾德市最大島嶼Otrøya(緯度: 63.510617，經度: 9.210989)發現的尖晶石類新礦物執明石成分接近 $NiAl_2O_4$ (介電陶磁與抗溫室氣體排放的催化材料)，黃士龍曾在1987年觀察鎳基超合金鋁化塗層的擴散氧化層中巧遇，但是自然界未曾發現。執明石產狀為挪威超高壓變質的西部片麻岩區域(Western Gneiss Region)，包裹於地涵富矽石榴子石中因鎳溶液侵入氧化反應而成，反映了此區超高壓變質岩特殊的退質溫壓成分環境。本研究團隊過去二十年於地球和隕石標本發現了六種新礦物(請參考下頁文獻與簡圖)*，執明石排序第七，以王執明教授命名，藉以感念王教授過去在台大地質系嚴格教導礦物偏光顯微鏡學，退休後努力推廣台灣地科教育，同時感謝王教授夫婿李國祁教授在1980年代對於中山大學教務的奉獻。

*按：本研究團隊曾在隕石標本發現兩種新礦物，也以台灣前輩地質學家命名表達敬意，分別是matyhite $[Ca_{18}(Ca, \square)_2Fe^{2+}_2(PO_4)_{14}]$ ：馬廷英-雪峰礦(三斜晶系磷鐵鈣礦)(2016年IMA認證)紀念馬廷英教授，以及tsangpoite $[Ca_5(PO_4)_2(SiO_4)]$ ：滄波石(六方晶系矽磷鈣石)(2015年IMA認證)紀念顏滄波教授。而國外學者發現的lingunite $[(Na,Ca)AlSi_3O_8]$ 玲根石(2004年IMA認證)以及liuite $[FeTiO_3]$ 劉氏直鈦鐵礦(2018年IMA認證)則以也曾在台灣任職的劉玲根博士命名。

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Chihmingite: a new spinel group mineral in relict majoritic garnet from the Western Gneiss Region, Norway

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Abstract

Chihmingite (執明石), a new spinel group mineral with the empirical formula $(\text{Ni}_{0.60}\text{Mg}_{0.36}\text{Fe}_{0.04})_{\Sigma 1.00}(\text{Al}_{1.94}\text{Cr}_{0.04}\text{Si}_{0.01})_{\Sigma 1.99}\text{O}_4$ and the ideal formula NiAl_2O_4 , has been identified as micrometer-size inclusions in relict majoritic garnet from the Ugelvik garnet peridotite body on Otrøy Island, Western Gneiss Region, Norway. Chihmingite has a cubic structure with $a = 8.059(5) \text{ \AA}$, $V = 523.4(10) \text{ \AA}^3$, $Z = 8$, and is found to be associated with nickel, nickel sulfide, kyanite, Ni-rich mica, Ni/Al-rich enstatite, Ni-rich hornblende, and Ni-rich sapphirine as multi-phase inclusions in relict pyrope garnet. It is concluded that chihmingite could not be a direct reaction product between Ni and the garnet host. Instead, chihmingite first epitaxially nucleated/grew upon pre-existing Ky-plate at near Ni crystal surface from a precursor NiO-rich siliceous melt, which likely formed via the reaction between garnet and Ni crystal besides the intruding oxidizing melt/fluid. Chihmingite is named in honor of the late Prof. Chih-Ming Wang Lee (王執明, 1930-2020), the first woman professor in Taiwan who lectured on optical mineralogy and crystal chemistry during her academic life at NTU.

Note that there are minerals in meteorite named after two pioneer geologists in Taiwan by the same research group in Taiwan, i.e. matyhite $[\text{Ca}_{18}(\text{Ca}, \square)_2\text{Fe}^{2+}_2(\text{PO}_4)_{14}]$: 馬廷英-雪峰礦(三斜晶系磷鐵鈣礦) after 馬廷英教授 and tsangpoite $[\text{Ca}_5(\text{PO}_4)_2(\text{SiO}_4)]$: 滄波石(六方晶系矽磷鈣石) after 顏滄波教授. Meanwhile, lingunite and liuite are named after 劉玲根博士 by foreign research groups.

Through global, extra-terrestrial and interdisciplinary efforts, geologists and materials scientists in Taiwan have identified a total of 7 unknown new minerals including $\alpha\text{-PbO}_2$ -type TiO_2 in 2000, kokchetavite in 2004, kumdykolite in 2009, kuratite in 2016, matyhite and tsangpoite in 2019 and Chihmingite in 2022. More findings are expected in future studies using transmission electron microscopy coupled with Raman probe or other advanced instruments to focus on submicron

domains with unusual optical birefringence selected by optical polarized microscopy which had been taught by Prof. Wang Lee at NTU.