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碩士論文

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Master Thesis

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東台灣玉里帶蛇紋岩與其圍岩之岩石學研究

Petrological characterization of serpentinites and related rocks from the Yuli belt, eastern Taiwan

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Abstract

The Yuli belt is considered a high-pressure (HP) metamorphic belt because glaucophane and/or omphacite occur in metabasite-serpentinite-dominated tectonic blocks embedded in metasedimentary rocks. These blocks are likely of oceanic crust protolith with the peak pressure-temperature (P-T) conditions implying a type of subduction metamorphism. However, the origin and metamorphic conditions of the serpentinites remain unknown. Serpentinite samples from the Fengtien and Tsunkuanshan area consist mainly of antigorite and magnetite, with minor brucite, olivine, diopside, chlorite, and talc. Micro-textural and mineral compositions of olivine (Fo_{95-96}) and diopside indicate a metamorphic origin. The stability field reactions among antigorite, olivine, diopside, and brucite imply dehydration metamorphism (400-550℃) producing meta-serpentinites. On the other hand, relict reddish-brown chromian spinel (Cr-spinel) is preserved in some samples surrounded by opaque ferritchromite and magnetite. Cr-spinel compositions are in the abyssal peridotite protolith range based on Cr# (0.44-0.55), Mg# (0.60-0.78), and Fe^{3+}# (<0.04). In the Tsunkuanshan area, meter-scale metasomatic zones occur at the contact between serpentinite bodies and metasedimentary country rocks. Five different rock types between serpentinites and metasedimentary rocks (garnet + phengite + quartz + albite + carbonaceous material ± rutile) are talc schist, chlorite schist, amphibole-albite rocks, greenstone/schist, and chlorite-albite schist/albitite. These rock associations are likely products of sodium (Na) metasomatism between these contrasting rock compositions. Three domains within amphibole-albite rocks exhibit two different amphibole zoning types and mineral compositions. Domain 1 includes unzoned barroisite/Mg-katophorite, whereas domain 2 contains zoned amphiboles from glaucophane core, barroisite mantle, to actinolite rim. These domains record three stages of metamorphic (re)crystallization. Stage 1 is represented by glaucophane recording blueschist-facies metamorphism. Stage 2 (barroisite/Mg-katophorite) and stage 3 (actinolite) indicate retrogression from epidote amphibolite- to greenschist-facies metamorphism. On the other hand, temperatures constrained by Raman Spectroscopy of Carbonaceous Material (RSCM) geothermometry on surrounding metasedimentary rocks yielded two different ranges in 480-520℃ (pelitic schist 1) and 400-415℃ (pelitic schist 2). The peak metamorphic conditions estimated from serpentinites, metasedimentary

rocks, and metasomatic rocks are similar. Serpentinites in the Fengtien and Tsunkuanshan areas are meta-serpentinites of possible abyssal peridotite protoliths. They might have been incorporated with metasedimentary rocks in a subduction system followed by metasomatic reactions in between under high-pressure metamorphic conditions. This study, therefore, interprets that serpentinites, metasedimentary rocks, and metasomatic rocks in the Tsunkuanshan area were likely metamorphosed isofacially.

Keywords: meta-serpentinite, protolith, chromian spinel, metasomatism, glaucophane, RSCM, subduction metamorphism.

摘要

玉里帶主要由原地片岩(in-situ schist)及包夾在其中的構造地塊(tectonic block)組成，因構造地塊含高壓指標礦物藍閃石(glaucophane)及綠輝石(omphacite)，因此玉里帶被認為是高壓變質帶，然而地塊中的蛇紋岩之來源及變質條件尚未釐清，因此無法得知是否也經歷過高壓變質環境。本研究之蛇紋岩樣本取自豐田及瑞穗尊古安山地塊，其礦物組合為葉蛇紋石、磁鐵礦、水鎂石、橄欖石、透輝石、綠泥石及滑石，而葉蛇紋石、橄欖石、透輝石及水鎂石的穩定生成條件約在400-550℃，透過岩象觀察及橄欖石的高鎂成分(Fo_{95-96})推論其為變質橄欖石，玉里帶蛇紋岩曾再經歷過變質作用，故應改稱為變質蛇紋岩(meta-serpentinite)。部分樣本中含殘餘的鉻尖晶石($Cr^{\#}$=0.44-0.55, $Mg^{\#}$=0.60-0.78, and $Fe^{3+\#}$<0.04)隱示蛇紋岩的原岩可能為洋底橄欖岩。尊古安山的蛇紋岩與其圍岩變質泥質岩之間新發現具含藍閃石之交代換質帶(metasomatic zone)，透過礦物化學成分分析得知角閃石環帶由核部向邊部的變化為藍閃石→凍藍閃石→陽起石，隱示其變質環境從綠簾角閃岩相退變質至綠片岩相。本研究利用含碳物質-拉曼地質溫度計(Raman Spectroscopy of Carbonaceous Material, RSCM)估算圍岩之變質泥質岩及千枚岩之變質峰期溫度分別為 480-520℃ 與 400-415℃。綜合野外調查及變質溫度估算結果推論蛇紋岩及其圍岩可能經歷相近的變質條件。

關鍵字：變質蛇紋岩、鉻尖晶石、交代換質、藍閃石、含碳物質-拉曼地質溫度計、隱沒作用變質