Relationships between eclogite-facies mineral assemblages, deformation microstructures, and seismic properties in the Yuka terrane, North Qaidam ultrahigh-pressure metamorphic belt, NW China

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Abstract

To understand the relationships between eclogite-facies mineral assemblages, deformation microstructures, and the seismic properties of subducting oceanic crust, eclogites from the Yuka terrane, North Qaidam ultrahigh-pressure metamorphic belt, NW China were studied. Observations of mineral textures, deformation microstructures, and petrofabrics in the eclogites indicate that garnet, omphacite, and phengite were deformed by intra-crystalline deformation (i.e., dislocation creep) during prograde metamorphism. In contrast, amphibole, which was formed by the topotactic replacement of omphacite at fluid-present conditions, is considered to have been deformed by diffusional flow (dissolution–precipitation creep) during amphibolite-facies retrogression associated with exhumation. Based on the petrofabrics in the samples, the seismic properties of the eclogites were calculated depending on eclogite-facies mineral assemblages such as garnet + omphacite (GO), garnet + omphacite + phengite (GOP), garnet + omphacite + phengite + lawsonite (GOPL), garnet + omphacite + phengite + amphibole (GOPA), and garnet + omphacite + amphibole (GOA). We found that the seismic signatures of each of the eclogite-facies mineral assemblages were different. In particular, phengite-bearing eclogites (the GOP/GOPA assemblages), depending on phengite content, produced the strongest seismic anisotropy (AVp and AVs), with a strong polarization anisotropy, that was at least three times higher than bimineralic (phengite-absent) eclogite (GO assemblage). Our results show that phengite, as a stable phase at high pressure and temperature conditions, can play an important role in the creation of trench-parallel seismic anisotropy in the eclogite-facies mineral assemblages found in subduction zones.

Relationships between eclogite-facies mineral assemblages, deformation microstructures, and seismic properties in the Yuka terrane, North Qaidam UHP metamorphic belt, NW China

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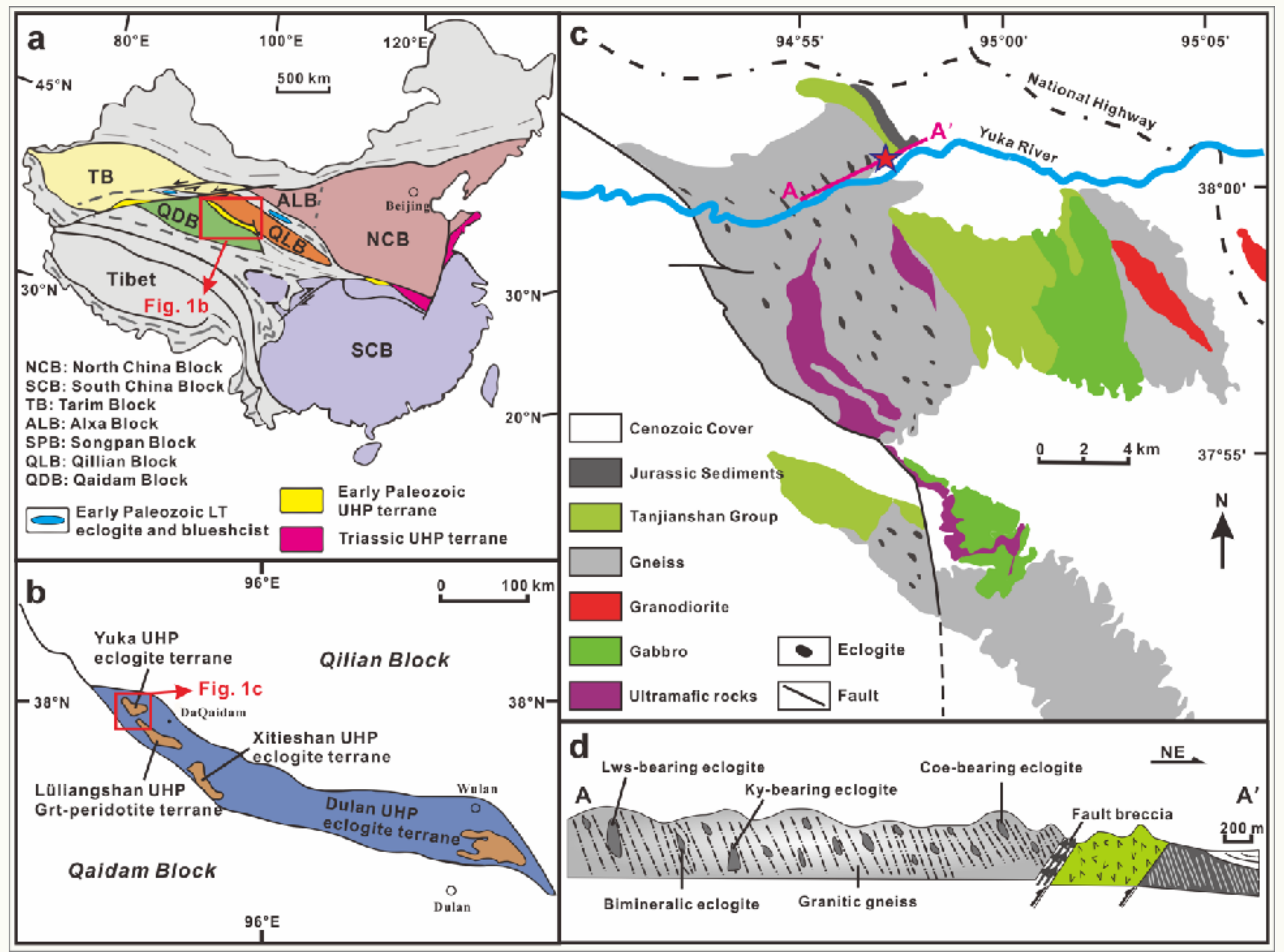
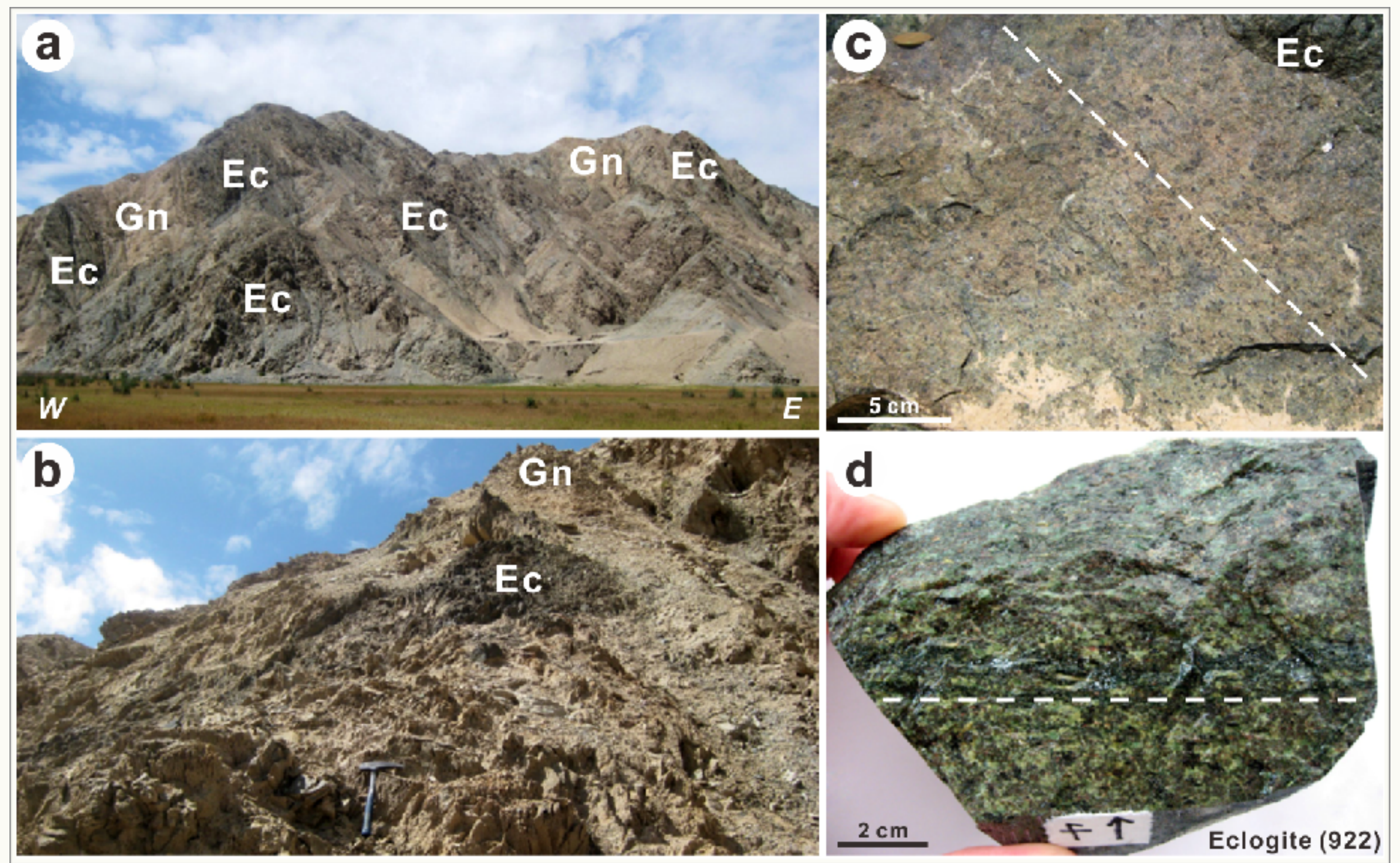
I. INTRODUCTION

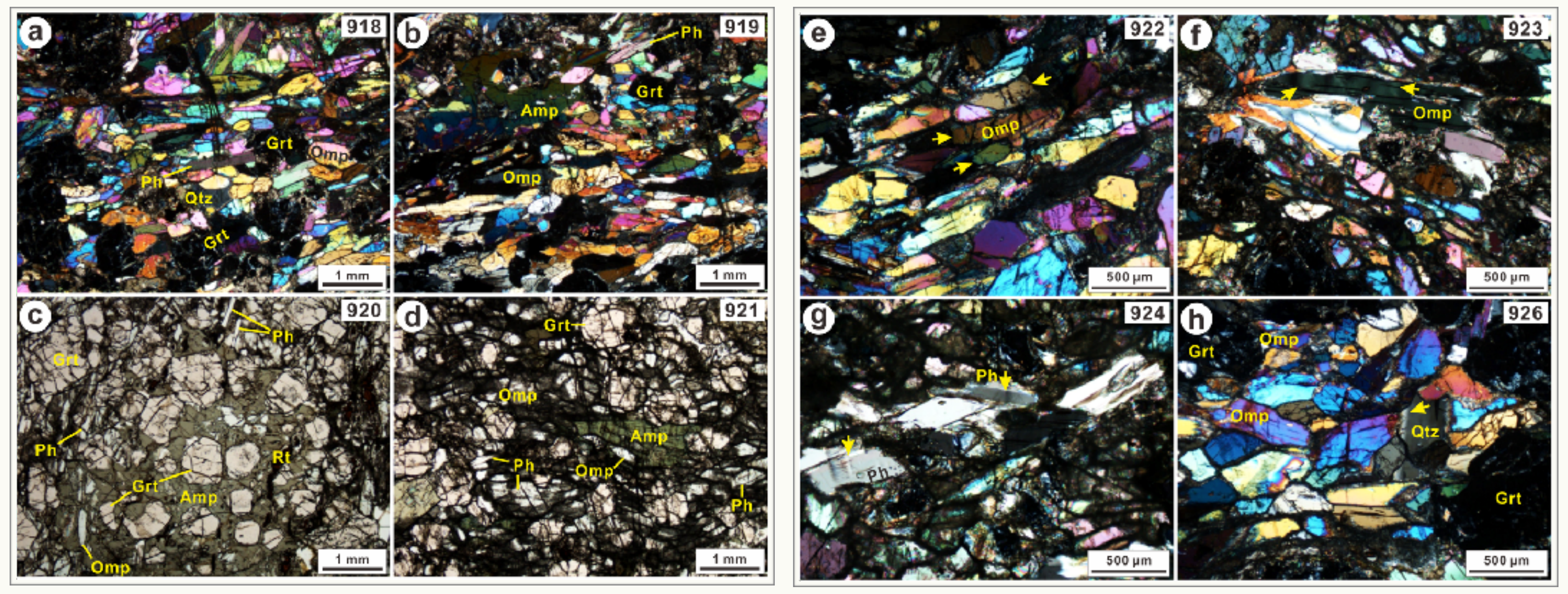
Although phengite is a common high-pressure phase in eclogite-facies rocks from numerous locations worldwide, studies on the seismic properties of phengite in eclogites have been limited. Moreover, how mineral assemblage-dependent seismic properties evolve during prograde and retrograde metamorphism has never been reported. Therefore, the focus of this study is to distinguish the characteristic seismic properties of a range of eclogite-facies mineral assemblages. For this purpose, we studied the Yuka ultrahigh-pressure eclogites from North Qaidam terrane in northwestern China.

2. STUDY AREA & FIELD OBSERVATION



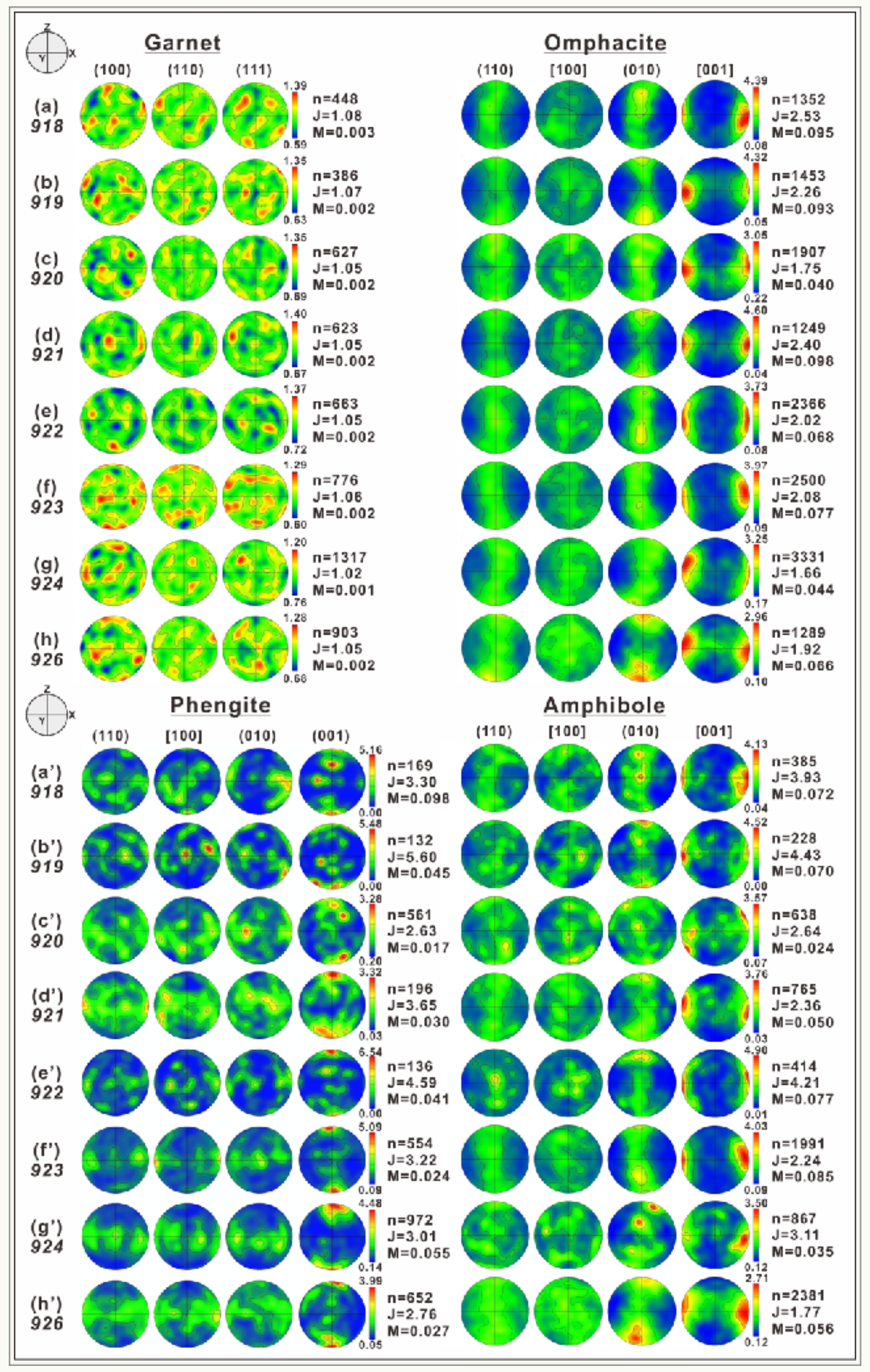


3. MICROSTRUCTURES in XZ plane



- Mineral Volume Fraction: Garnet (Grt 13–22%), Omphacite (Omp 25–67%), Phengite (Ph 2–15%), Amphibole (Amp 10–46%) with minor Rutile (Rt) & Quartz (Qtz)
- Omp (up to 43% jadeite): strong SPOs, sub-grain boundaries, & undulose extinction.
- Ph (Si = 3.38–3.43): strong SPOs, sub-grain boundaries, undulose extinction, & kink bands.
- Amp (edenite/barroisite/hornblende): a weak/moderate SPO & lack of internal deformation.
- Yellow arrows indicate sub-grain boundaries and/or undulose extinction.

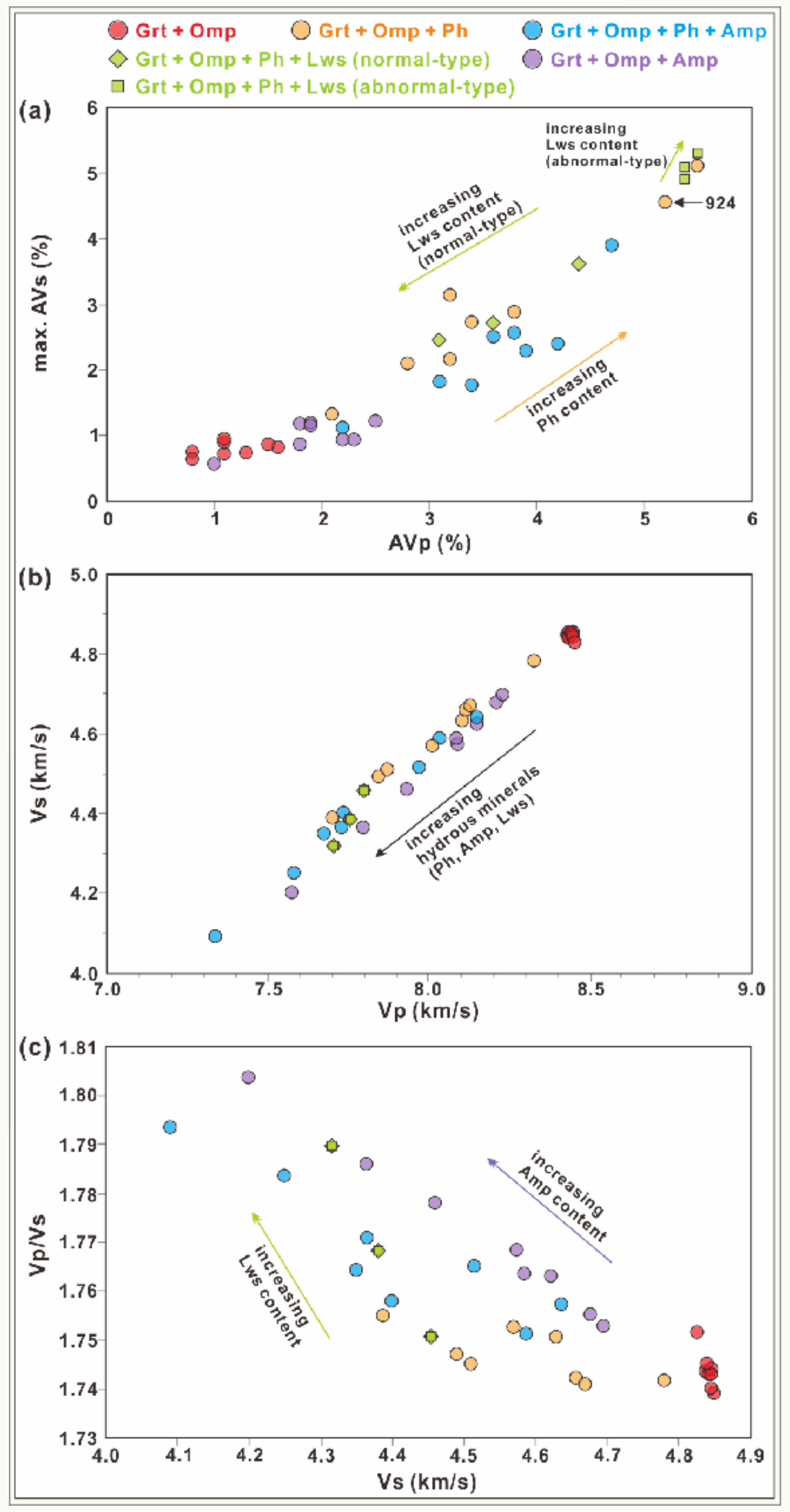
4. LPOs of Garnet, Omphacite, Phengite, & Amphibole

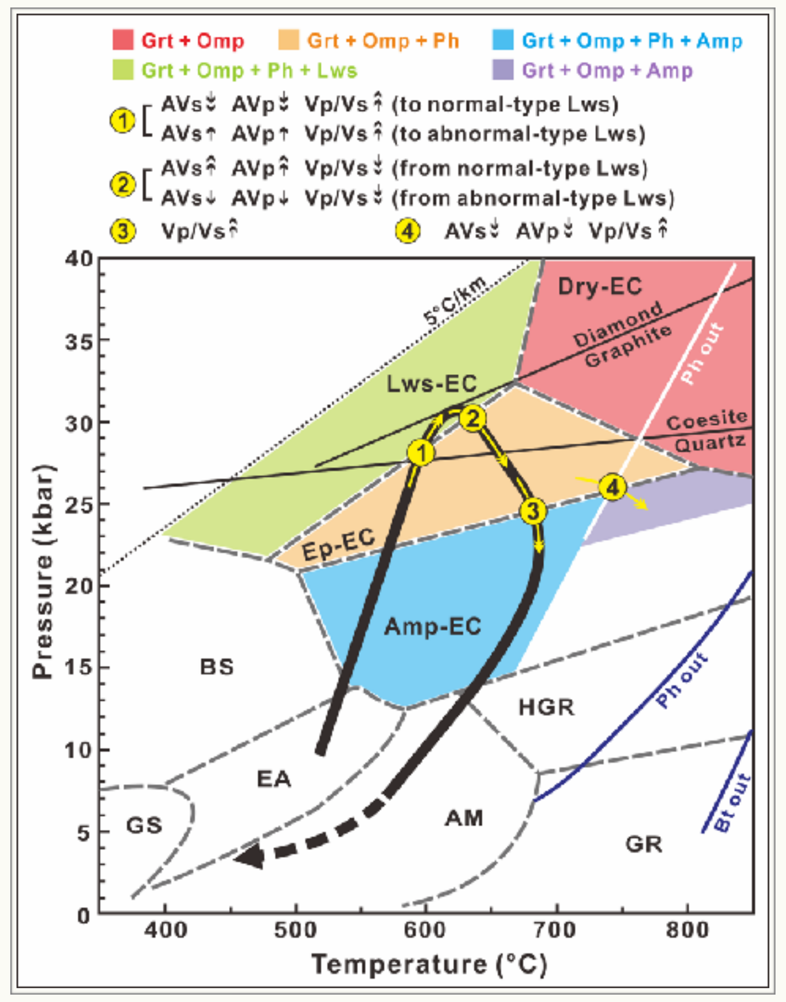


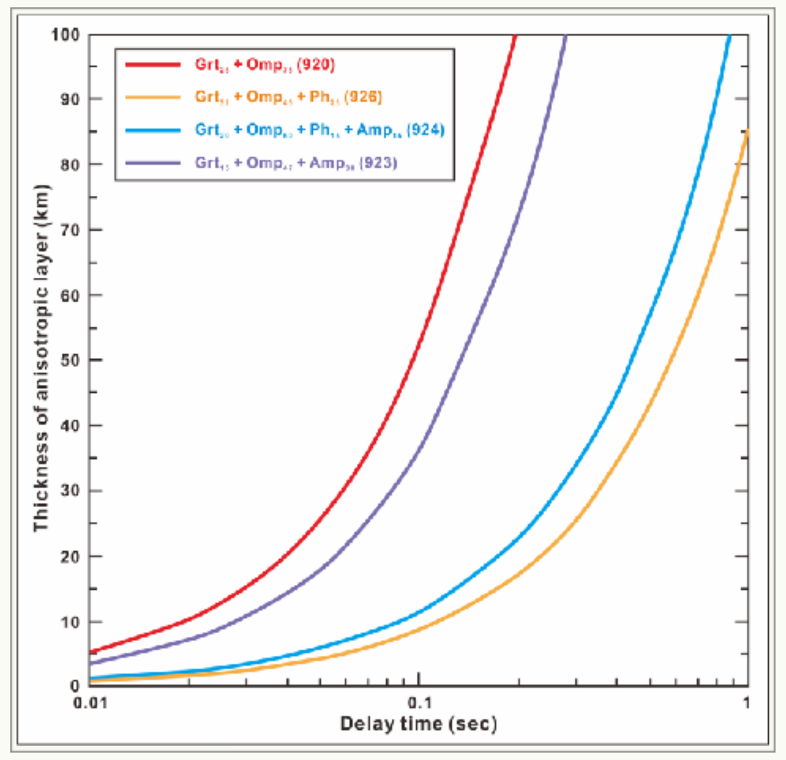
Pole figures are presented in lower hemisphere using equal area projection, and contoured with a half width of 20°. The east-west direction corresponds to stretching lineation (X), and the north-south direction (Z) is normal to foliation. N represents the number of measured grains. Fabric (LPO) strength is denoted as J (J-index) & M (M-index).

- Garnet
  - ✓ Weak/complex with diverse point maxima of (100), (110), & (111)
  - ✓ Low fabric strength
- Omphacite
  - ✓ L-type LPO: [001] axes // X & (010) poles (girdles) ⊥ X
  - ✓ Moderate fabric strength
- Phengite
  - ✓ [001] axes ⊥ XY & the others scattering along a girdle within XY
  - ✓ Strong fabric strength
- Amphibole
  - ✓ [001] axes // X & (010) poles (girdles) ⊥ X
  - ✓ Fabric strength: little smaller than phengite

5. SEISMIC ANISOPROPY in eclogite-facies mineral assemblages

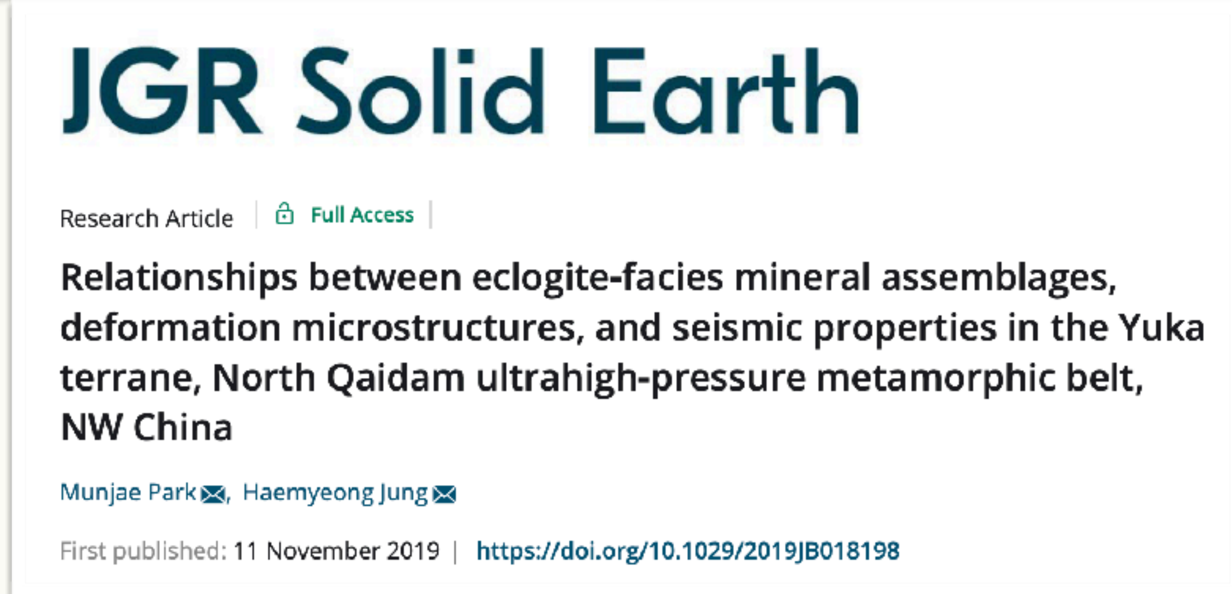






6. KEY POINTS of THIS STUDY

- Seismic signatures are distinct for different eclogite-facies mineral assemblages.
- Phengite-bearing eclogite produces the strongest seismic anisotropy among different eclogite-facies mineral assemblages.
- Phengite in eclogite-facies mineral assemblages can play an important role in the creation of seismic anisotropy in subduction zones.



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