

Petrogenesis and Lu–Hf dating of (ultra)mafic rocks from the Kutná Hora Crystalline Complex: implications for the Devonian evolution of the Bohemian Massif



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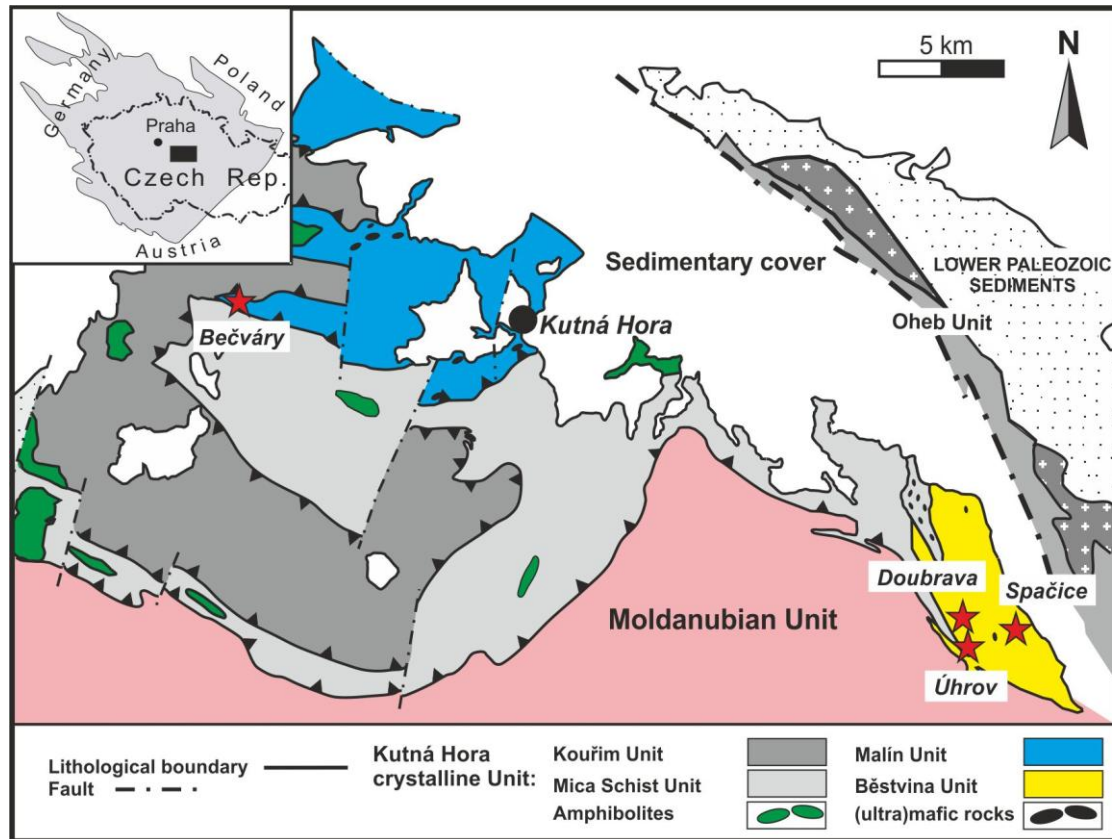
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Kutná Hora Crystalline Complex

Bohemian Massif, eastern part of the European Variscan Belt



UHP terrane

fragments/boudins of garnet peridotites, pyroxenites, eclogites

Medaris et al. 2005, Faryad 2009, Faryad et al. 2009

UHPM rocks (diamond, coesite, Perraki – Faryad 2014)

= deep subduction

geochronological data 380-360 and 340-330
for both mantle and crustal rocks

= complete geochronological record



key area for studying crust-mantle interaction
and constraining geodynamic evolution of the Bohemian Massif

- new Lu–Hf geochronological data for (ultra)mafic rocks interpreted based on a detailed study of petrography, multiphase solid inclusions in garnet, and mineral trace element composition and zoning
- whole-rock major and trace element compositions and Sr–Nd–Hf–Os isotopic systematics = extent, environment and timing of depletion and enrichment/refertilization of the KHCC peridotites

Studied samples: mineral assemblages and modal composition

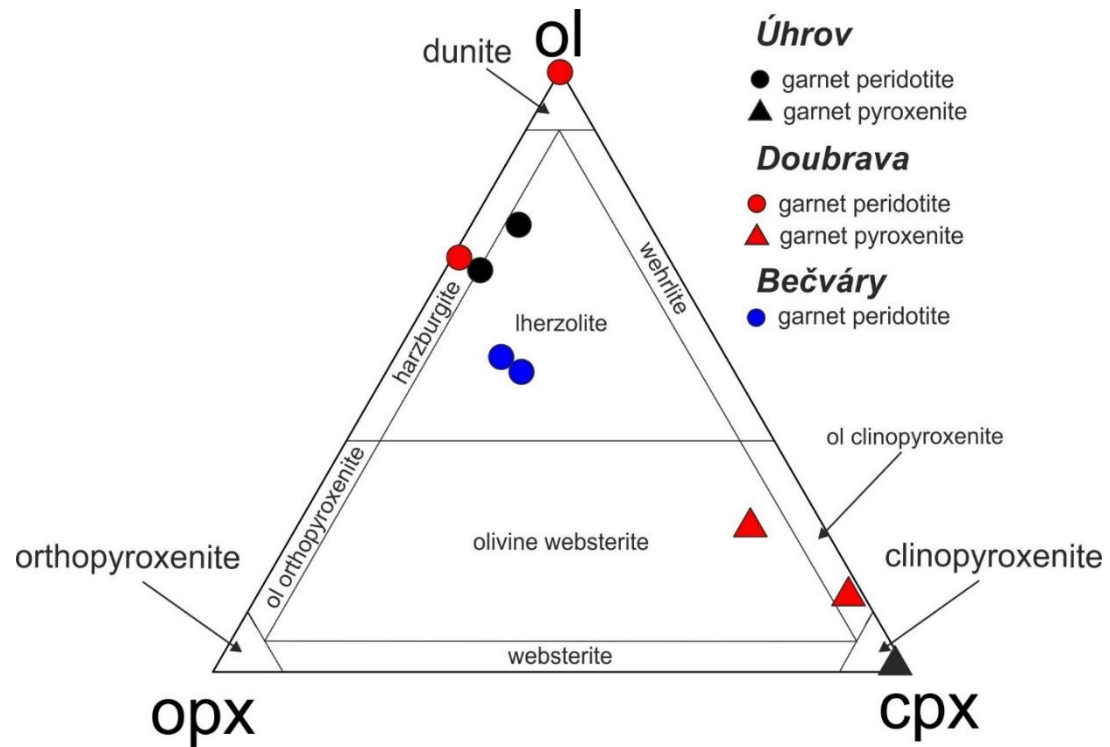


Table 1: Summary of the studied samples from the Kutná Hora Crystalline Complex and their modal composition

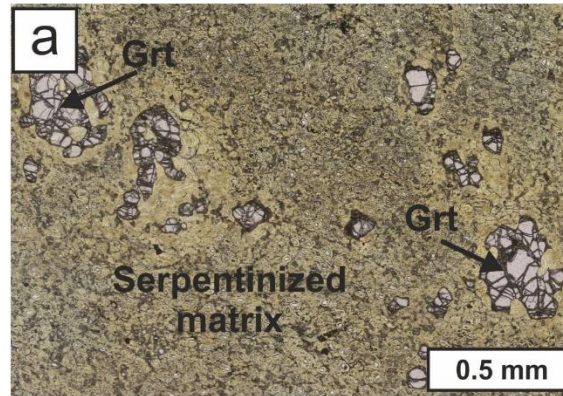
Sample	Locality	Lithology	Bulk modal composition (wt. %)			
			Ol	Opx	Cpx	Grt
Peridotites						
Uhr17a	Úhrov	Grt Lherz	68	17	6	8
Uhr17b	Úhrov	Grt Lherz	62	26	5	7
Doub4	Doubrava	Spl±Grt Dun	>95	<5	<5	<5
Doub5	Doubrava	Spl-Grt Harz	69	30	1	<1
Bec1	Bečváry	Grt Lherz	42	26	12	19
Bec2	Bečváry	Grt Lherz	36	22	14	28
			Bulk modal composition (wt. %)			
Pyroxenites						
			Ol	Opx	Cpx	Grt
Uhr17c	Úhrov	Grt Clinopyroxenite		<1	56	54
Doub2	Doubrava	Ol-Grt Webs	23	10	62	5
Doub2b	Doubrava	Ol-Grt Clinopyroxenite	12	2	80	6
			Bulk modal composition (wt. %)			
Eclogites						
			Cpx	Grt	Pl	Qz
Urh_E	Úhrov	Ky Eclogite	15	37	16	32
Doub7	Doubrava	Eclogite	36	59	5	
Sp1f	Spačice	Ky Eclogite	60	25	15	
Sp1-16	Spačice	Ky Eclogite	7	53	19	21

Ol - olivine, Opx - orthopyroxene, Cpx - clinopyroxene, Grt - garnet, Pl - plagioclase, Spl - spinel

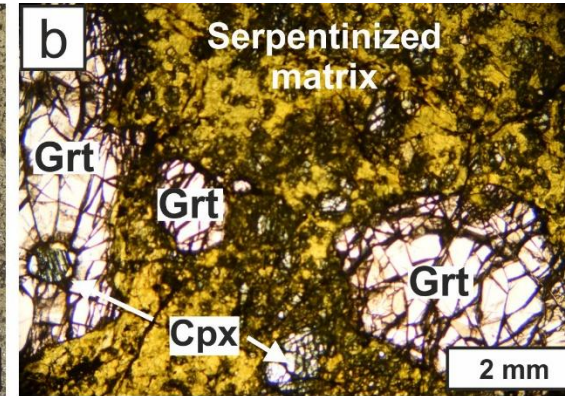
Qz - quartz, Ky - kyanite, lherz - Lherzolite, Harz - harzburgite, Dun - dunite, Webst - websterite

Studied samples: textures and major phases

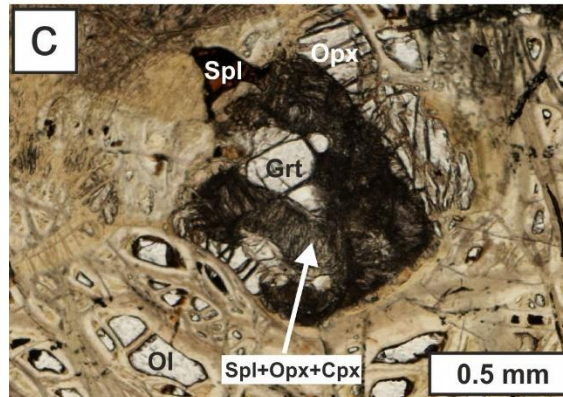
garnet lherzolite
Úhrov



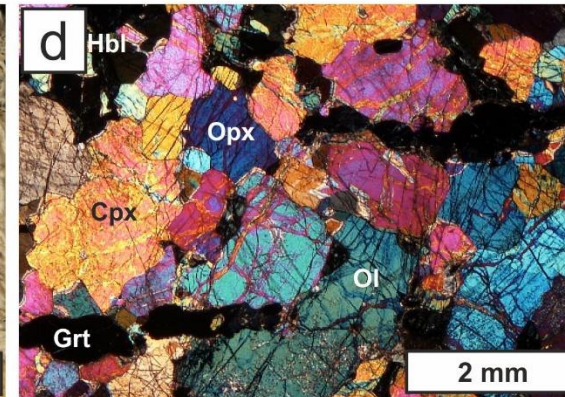
garnet lherzolite
Bečváry



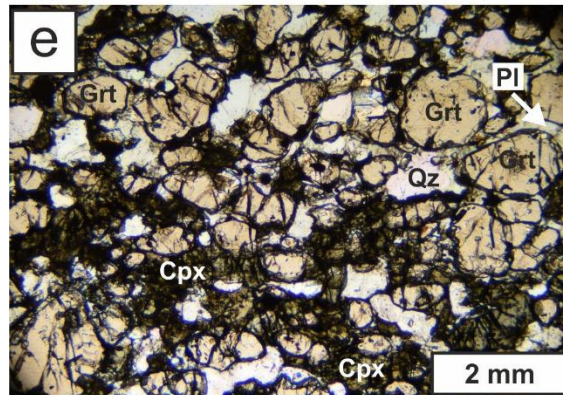
spinel-garnet harzburgite
Doubrava



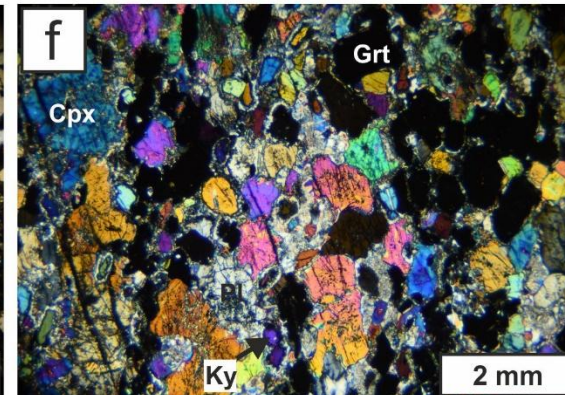
olivine-garnet websterite
Doubrava



kyanite eclogite
Úhrov



kyanite eclogite
Spačice

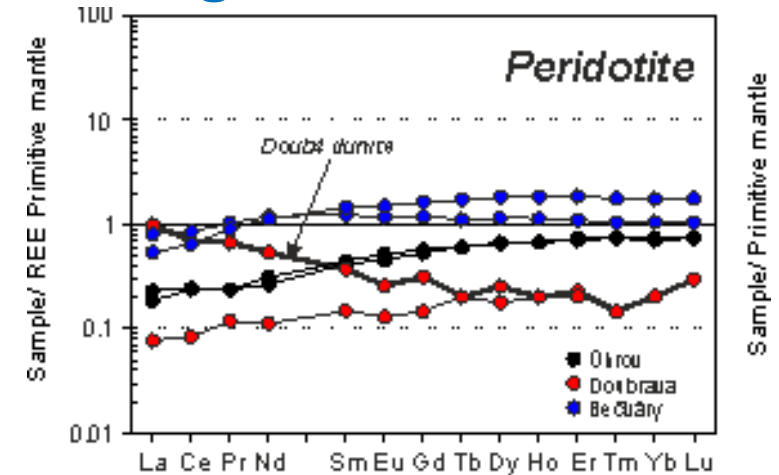


Petrogenesis of peridotite-pyroxenite assemblages and Lu-Hf dating

garnet lherzolite, Úhrov depleted oceanic asthenospheric mantle

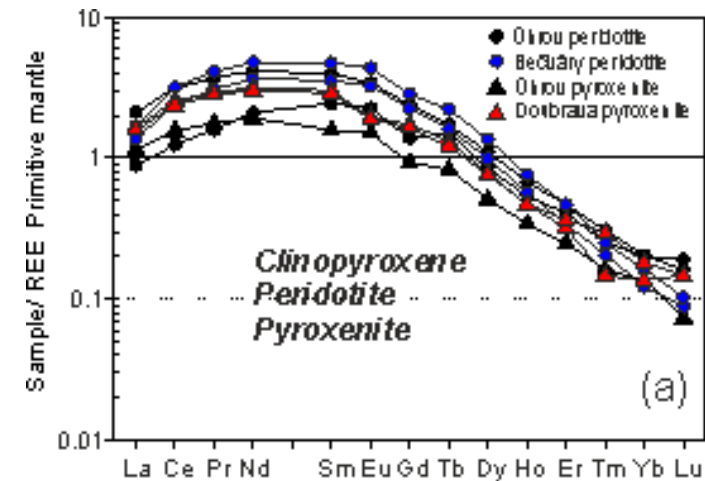
395 ± 23 Ma Grt-Opx+Cpx-Cpx-WR

low Cpx abundances (5–6 wt. % and ~ 1 wt. %), low Al_2O_3 and CaO
10 - 20 % partial melting
LREE-depleted patterns



garnet lherzolite, Bečváry extensive refertilization by basaltic melts associated with Grt±Cpx precipitation

up to 28 % of garnet – high Al_2O_3 , low Ol content, Cpx in garnet
low Mg #
low Os and high $^{187}\text{Re}/^{188}\text{Os}$
highly to mildly radiogenic Sr–Nd–Hf–Os isotopic compositions
+ negative HFSE anomalies in clinopyroxene
indicate only a very small contribution of recycled crustal component



multiphase solid inclusions (MSI) trapped in garnet, dominated by Ti and Fe-Ti oxides (rutile, ilmenite), represent relics of Ti-rich low-degree basaltic partial melt

minor hornblende/phlogopite and carbonate reflect mantle metasomatism by $\text{H}_2\text{O} \pm \text{CO}_2$ -bearing fluids

Petrogenesis of peridotite-pyroxenite assemblages and Lu-Hf dating

Doubrava peridotites interaction between depleted protolith and SiO_2 -undersaturated infiltrating basaltic melt with small proportion of recycled crust (~5 % when subducted oceanic crust is considered)

marked petrological variability = harzburgite to composite dunite-wehrlite/olivine-bearing pyroxenite

LREE and Fe enrichment of dunite

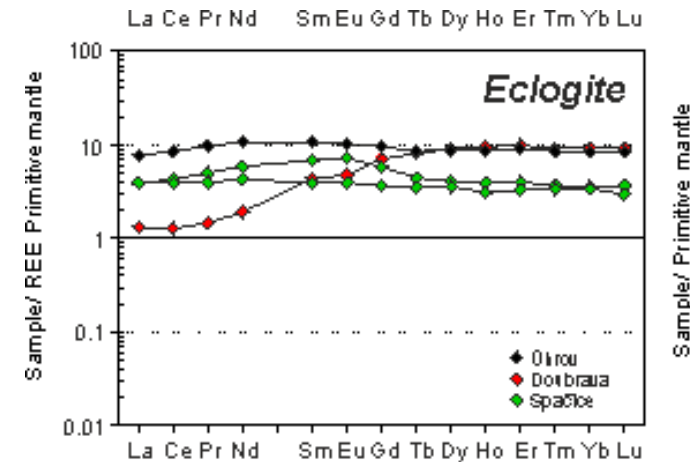
radiogenic present-day $^{187}\text{Os}/^{188}\text{Os}$ signature and the most pronounced HFSE negative anomalies in pyroxenites

KHCC eclogites

350 - 330 Ma Grt-Cpx-WR

diverse origins

products of high-pressure crystal accumulation from mantle-derived basaltic melts, or a fragment of MORB-like gabbroic cumulate and crustal-derived material both metamorphosed at HT-HP conditions



Proposed refined geodynamic model

~ 400 Ma subduction of the oceanic crust and associated oceanic asthenospheric mantle beneath the Teplá–Barrandian related to closure of the Saxothuringian ocean between Gondwana-derived microcontinents

overlying lithospheric mantle wedge was refertilized by fluids/melts

~ 370–360 Ma? continental subduction of the Saxothuringian crust
accompanied by the break-off of the eclogitized oceanic crust
facilitating incorporation of the upwelling asthenospheric mantle into the Moldanubian lithospheric mantle wedge

~ 350–330 Ma collision and coeval exhumation of mantle and crustal rocks
might be associated with mixing/mingling of crustal-derived melts and mafic lithologies
producing the observed geochemical and geochronological signatures

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