

IODP Expedition 345

Primitive Layered Gabbros From Fast-Spreading Lower Oceanic Crust

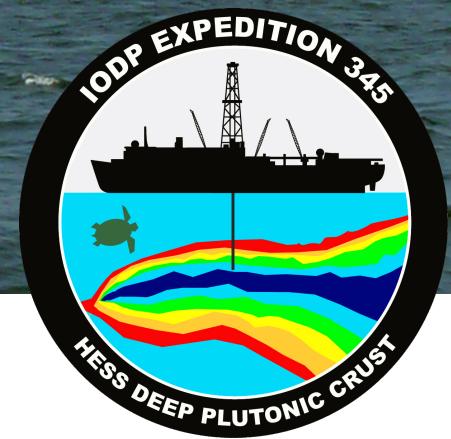
B. Ildefonse, K. Gillis, J.E. Snow, A. Klaus, & IODP Exp. 345 scientists

ildefonse@um2.fr

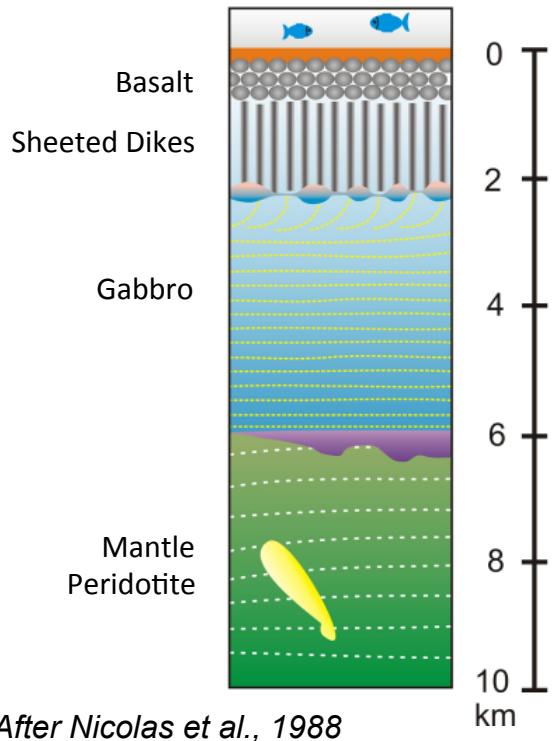
kgillis@uvic.ca

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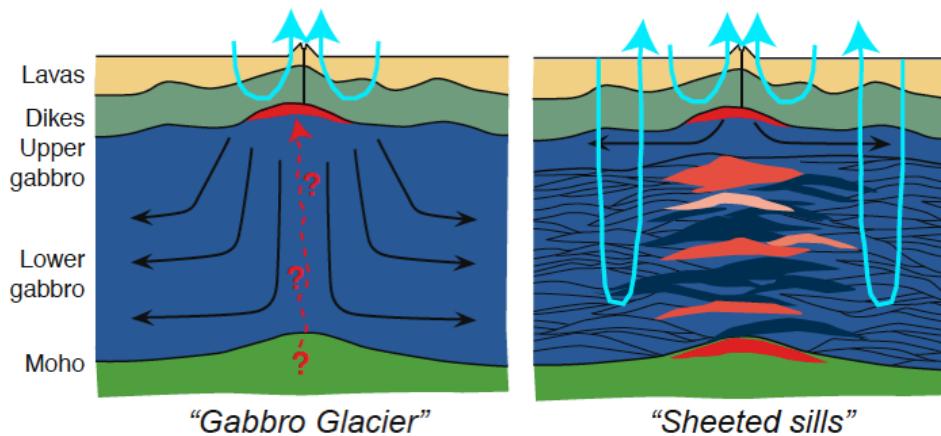


Objectives of Expedition 345



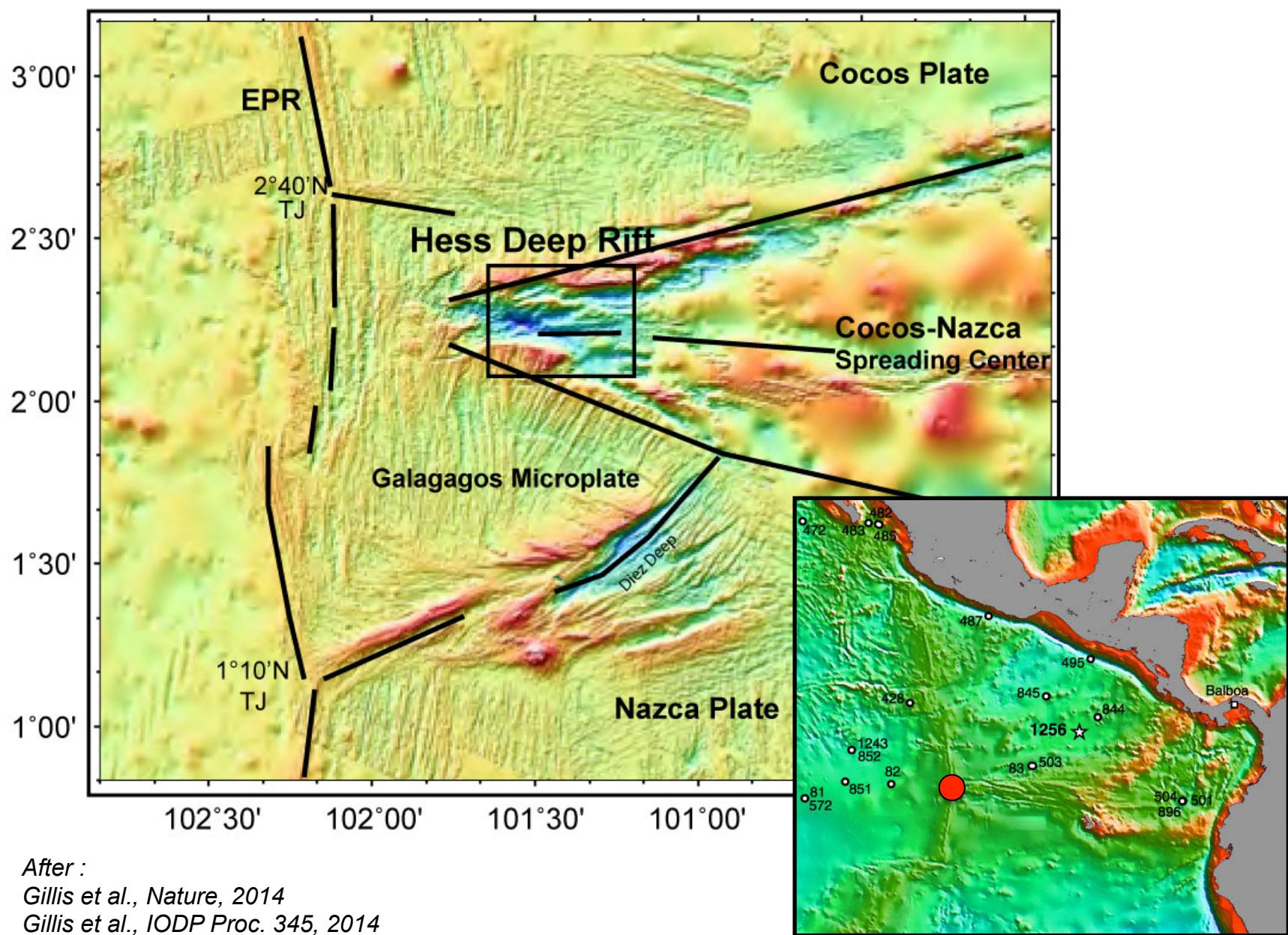
Target : deep primitive gabbroic rocks

- Testing competing hypotheses for the accretion and hydrothermal cooling at fast-spreading MORs
- Addressing specific questions :
 - Melt transport from the mantle through the lower crust ?
 - Is there layering ?
- Origin and significance?
 - Heat extraction from lower plutonic crust?
 - Fluid and geochemical fluxes in the EPR lower plutonic crust?

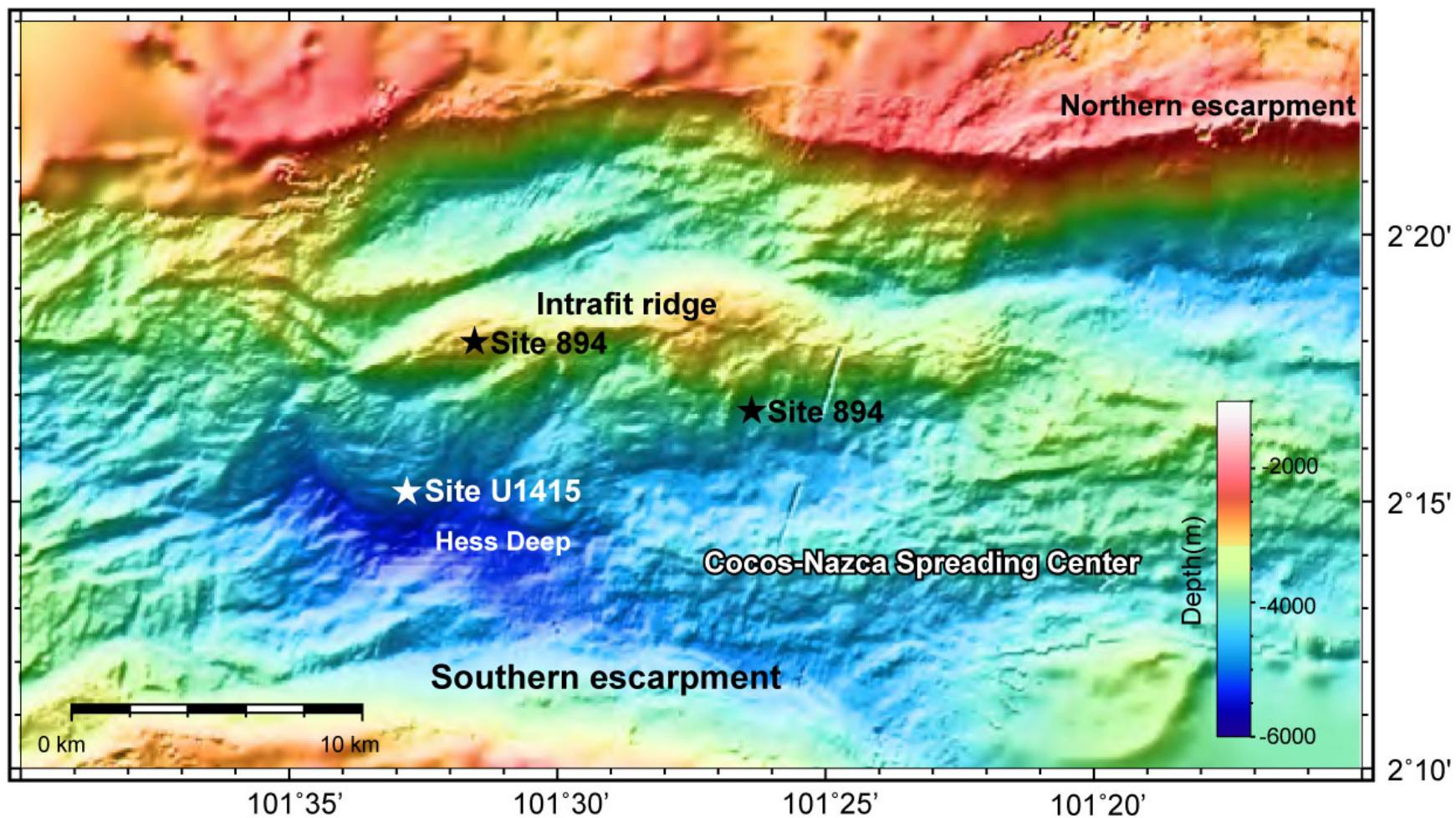


After Korenaga & Kelemen, EPSL, 1998

Expedition 345, Hess Deep, Dec. 2012 - Feb. 2013



Expedition 345, Hess Deep, Dec. 2012 - Feb. 2013

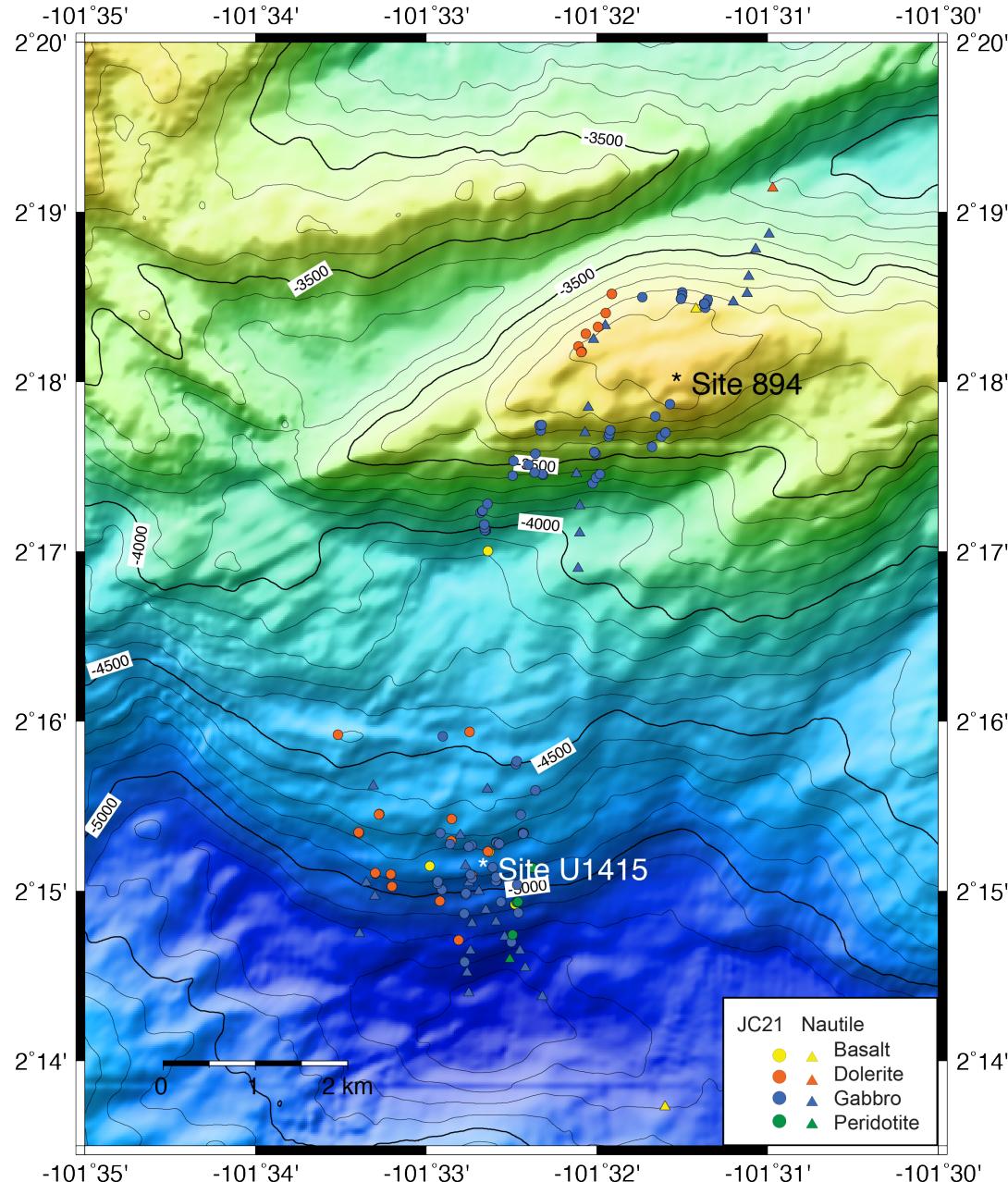


After :

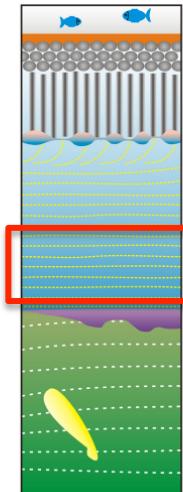
Gillis et al., Nature, 2014

Gillis et al., IODP Proc. 345, 2014

Lower Crust in Hess Deep



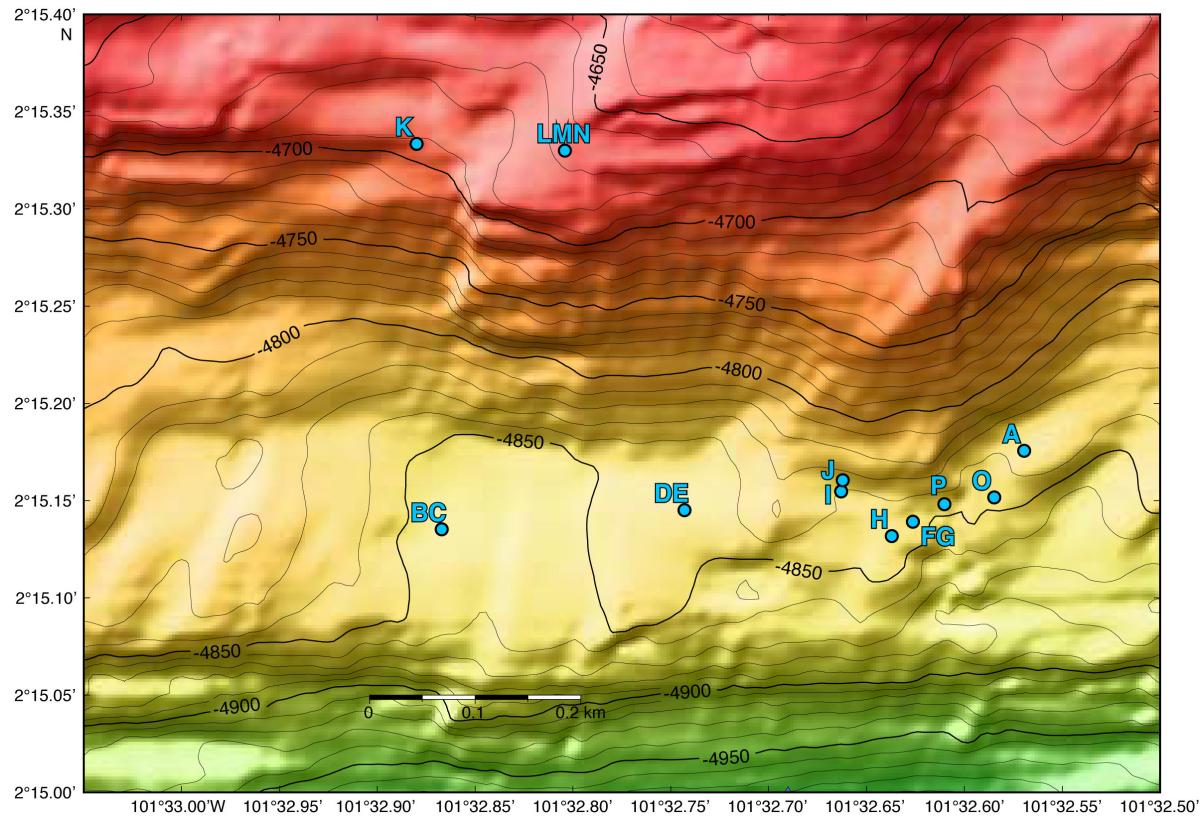
- ~1.2 Myr crust
(Rioux et al., 2012)
- Southern slope : rocks from the ~ lower half of the plutonic sequence



Seafloor Sample Information

- Nautili
Francheteau et al., EPSL, 1990
Hékinian et al., JGR, 1993
- JC21 (ROV Isis)
Rioux et al., Nature Geoscience, 2012
Lissenberg et al., EPSL, 2013

IODP Site U1415



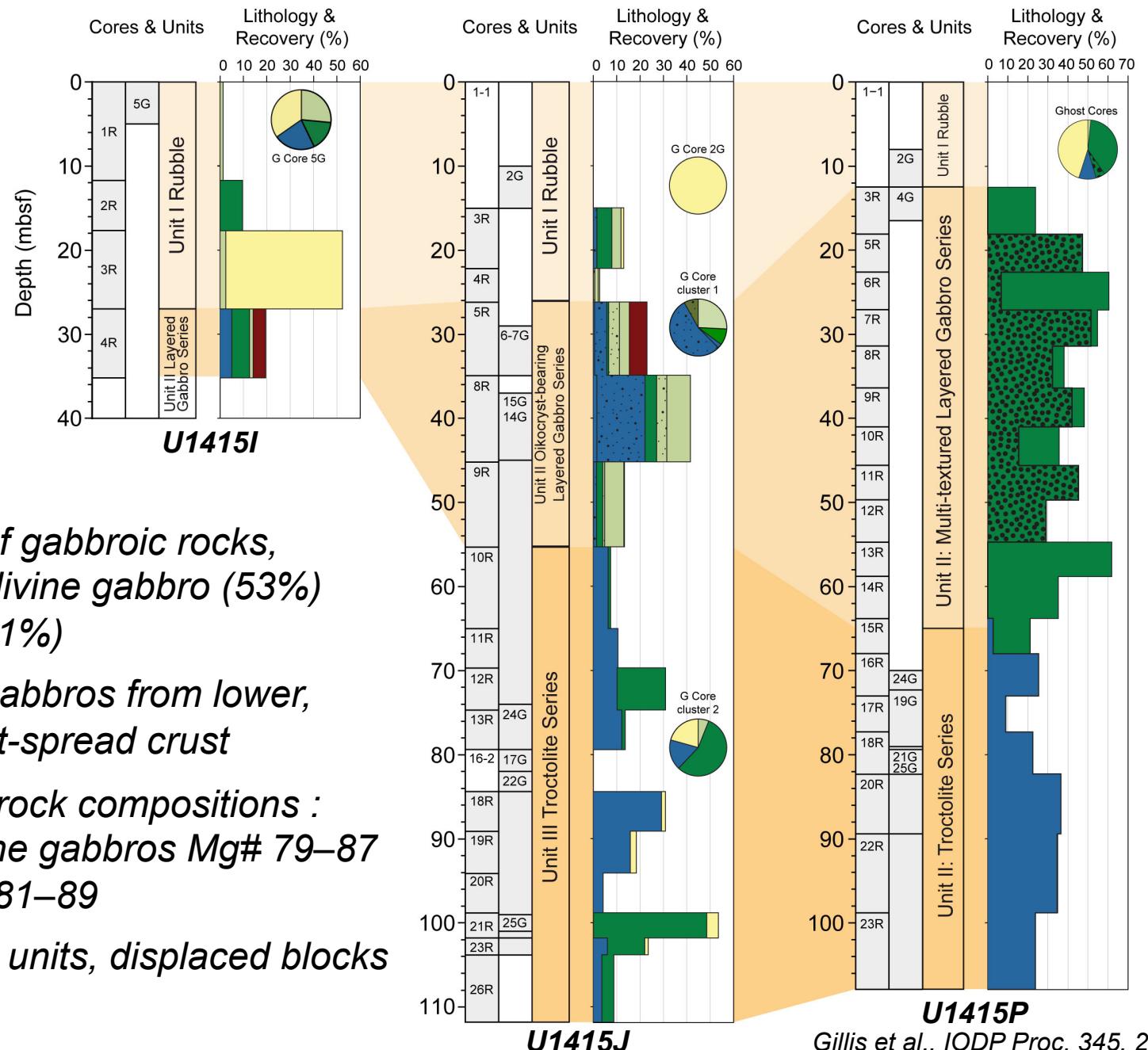
*Challenging drilling conditions
(water depth, slope, faults, rubbles, ...)*



IODP Site U1415



- █ Troctolite
- █ Oikocryst-bearing Troctolite
- █ Opx-bearing Olivine Gabbro
- █ Olivine Gabbro
- █ Gabbro
- █ Oikocryst Gabbro
- █ Gabbronorite
- █ Others

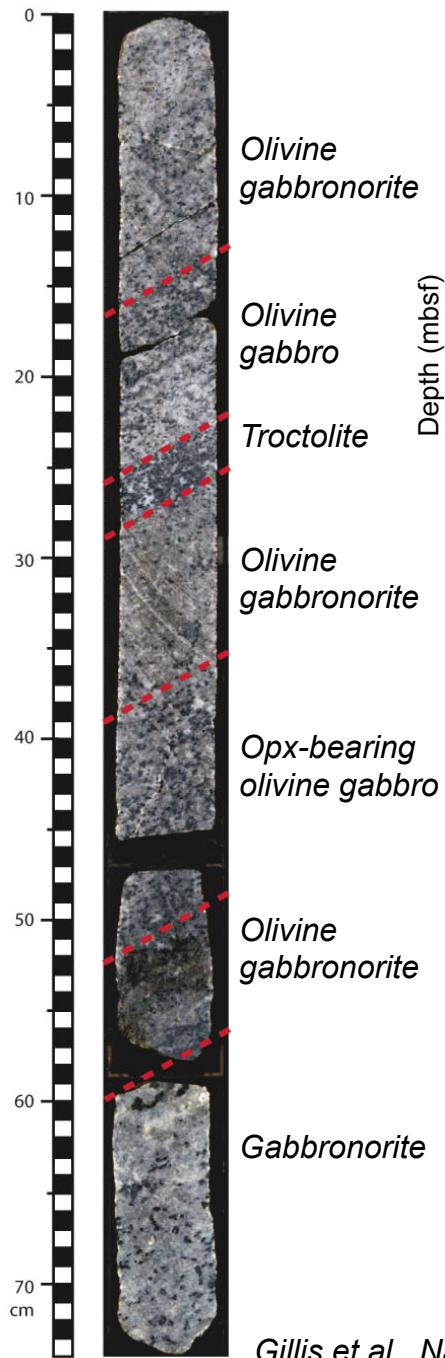


- Broad range of gabbroic rocks, dominated by olivine gabbro (53%) and troctolite (31%)
- First layered gabbros from lower, present-day fast-spread crust
- Primitive bulk rock compositions : Gabbros / Olivine gabbros Mg# 79–87 troctolites Mg# 81–89
- Discontinuous units, displaced blocks

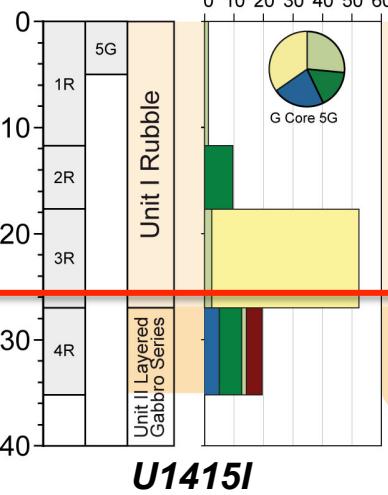
U1415-4R1



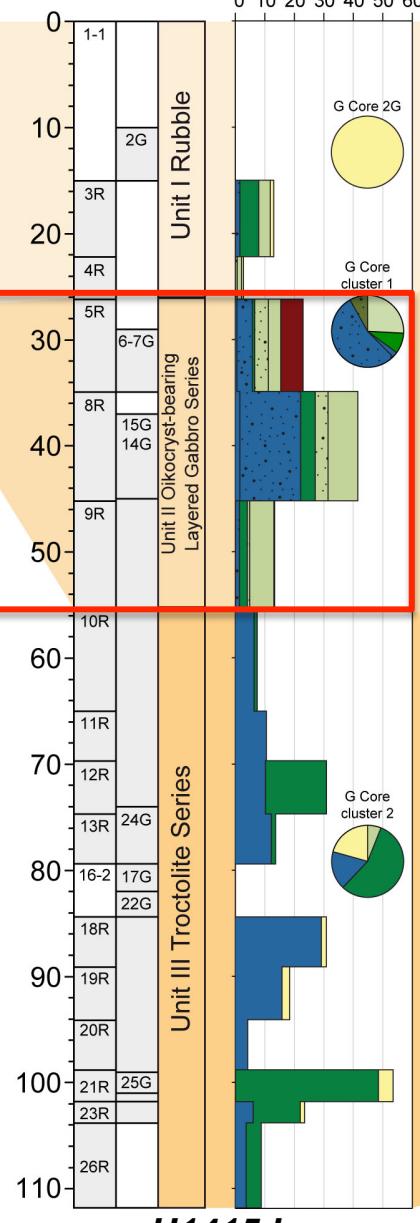
Layered Gabbros



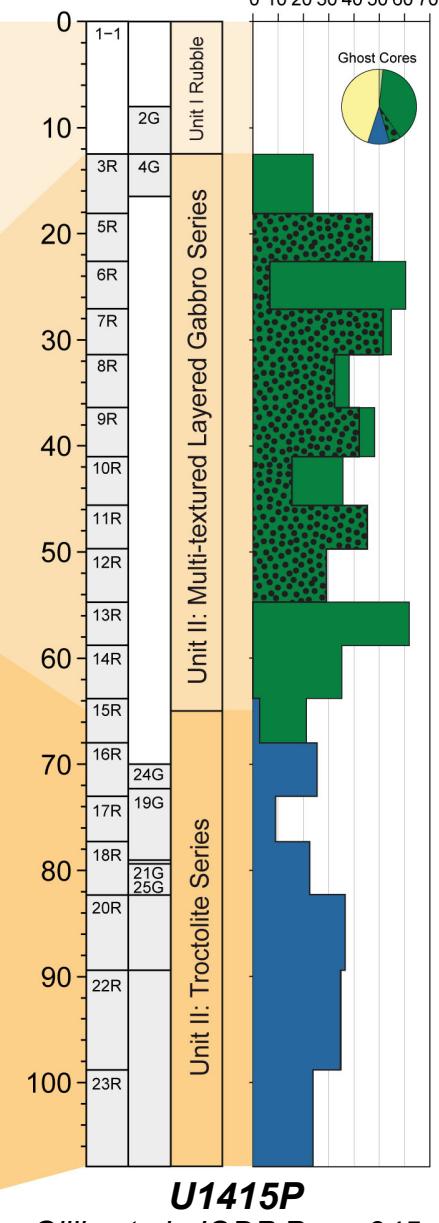
Cores & Units
Lithology & Recovery (%)



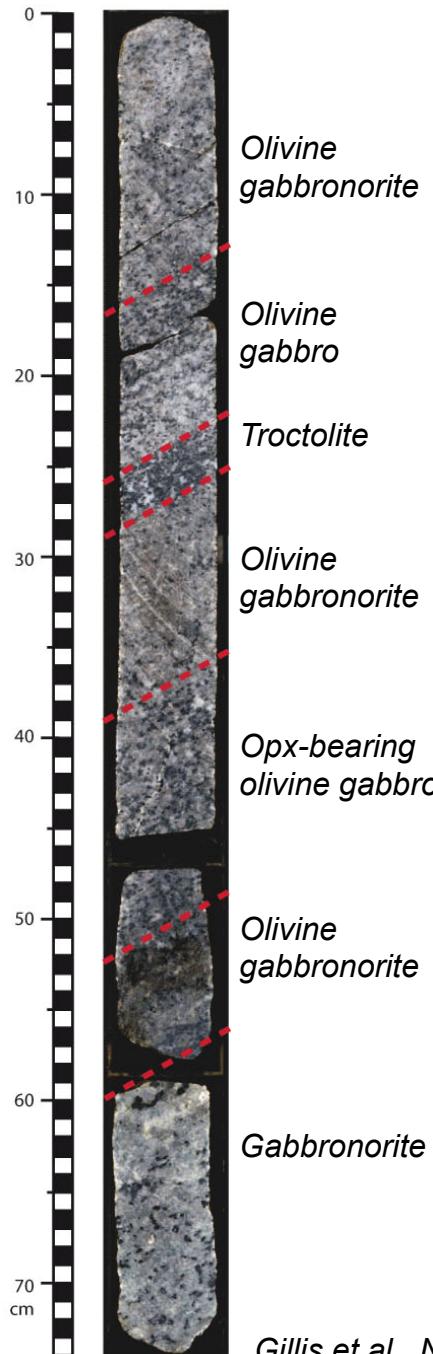
Cores & Units
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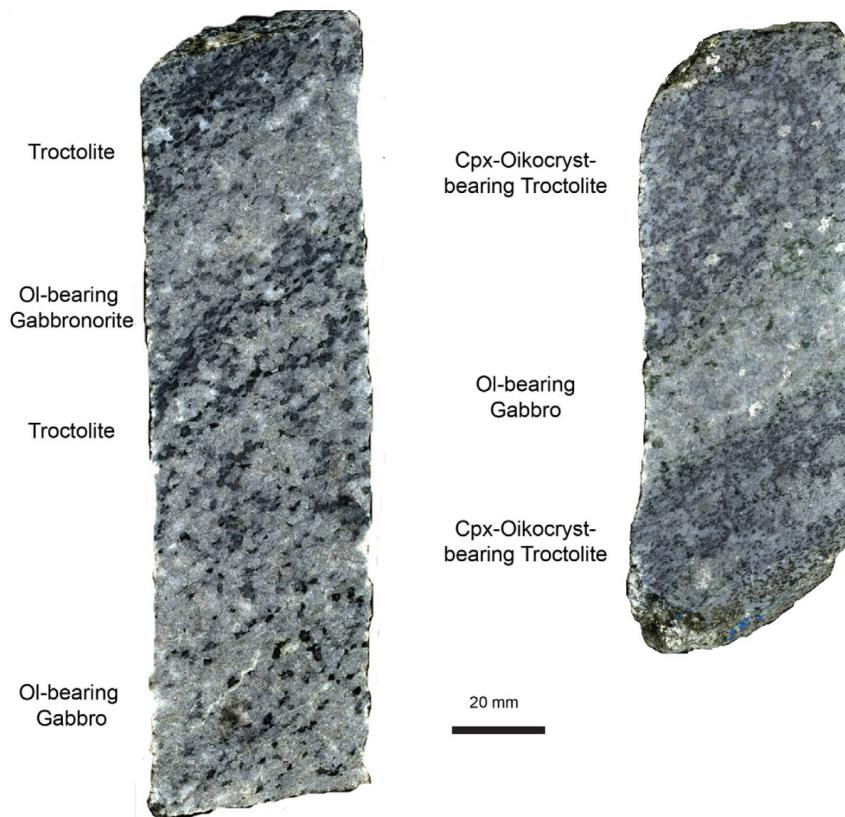
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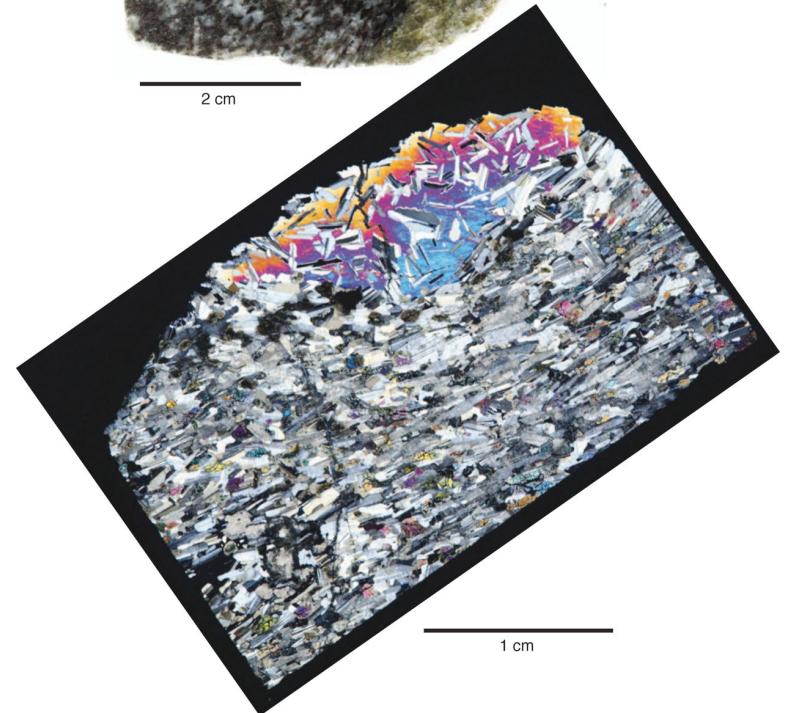
Layered Gabbros



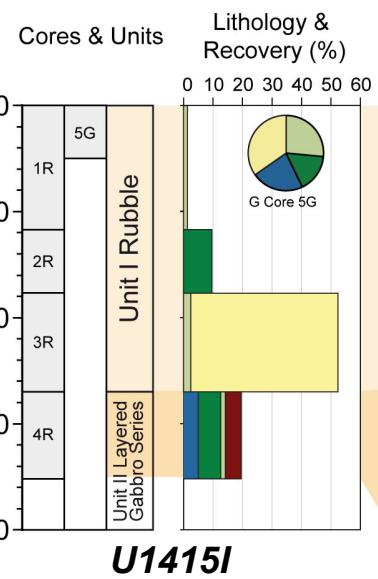
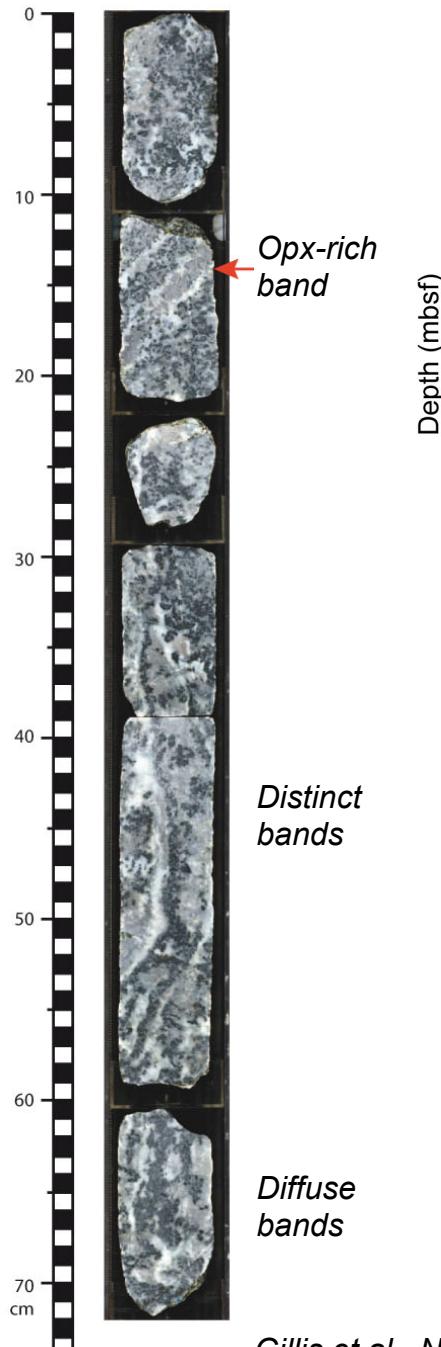
- Layers defined by modal and/or grain size variation, cms to dms thick
- Variety of lithologies
- Magmatic foliations parallel to layers, defined by shape-preferred orientation of plagioclase and olivine



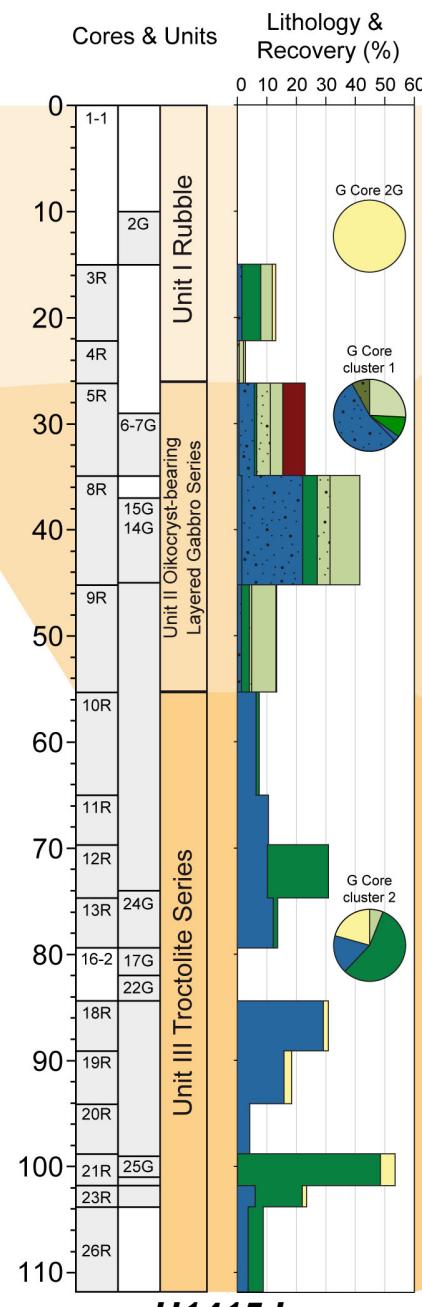
Cpx Oikocryst - Bearing Troctolites



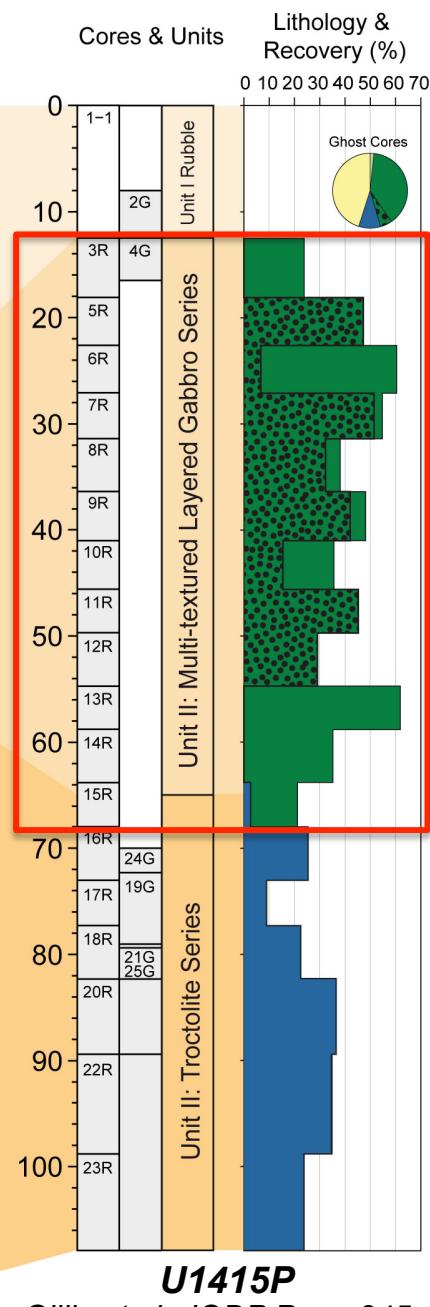
Banded Gabbros



U1415I



U1415J



U1415P

Banded Gabbros

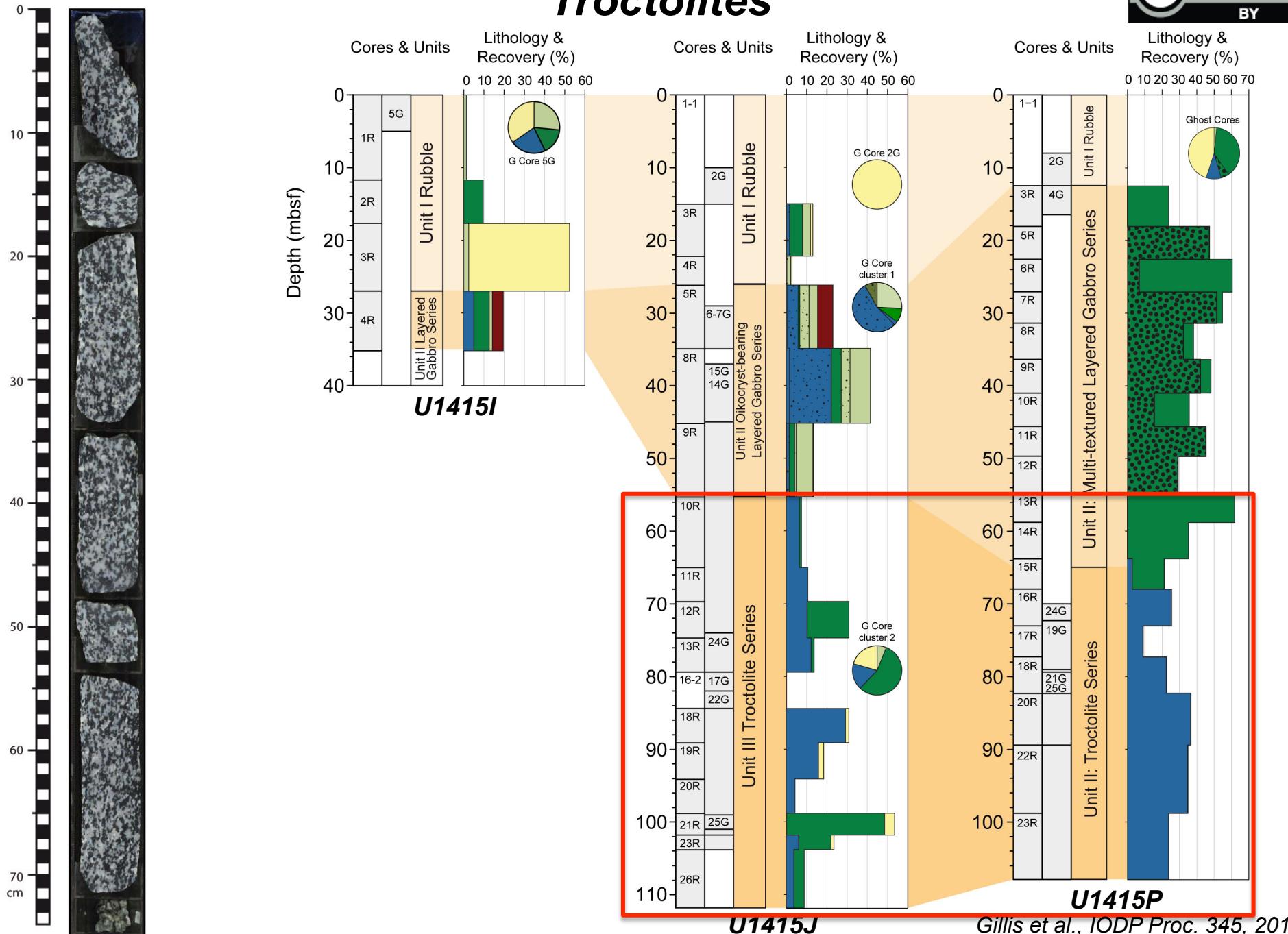


- *Leucocratic to melanocratic bands*
- *Defined by modal, grain size, and grain shape variations*
- *Mineralogically asymmetric*
- *Variable dip*
- *Foliation rare to absent*

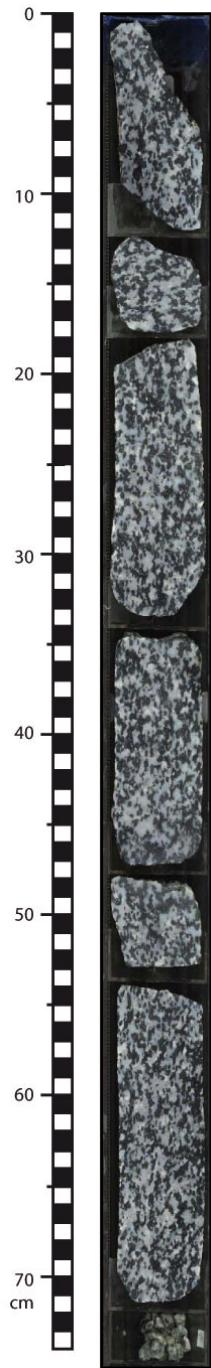




Troctolites

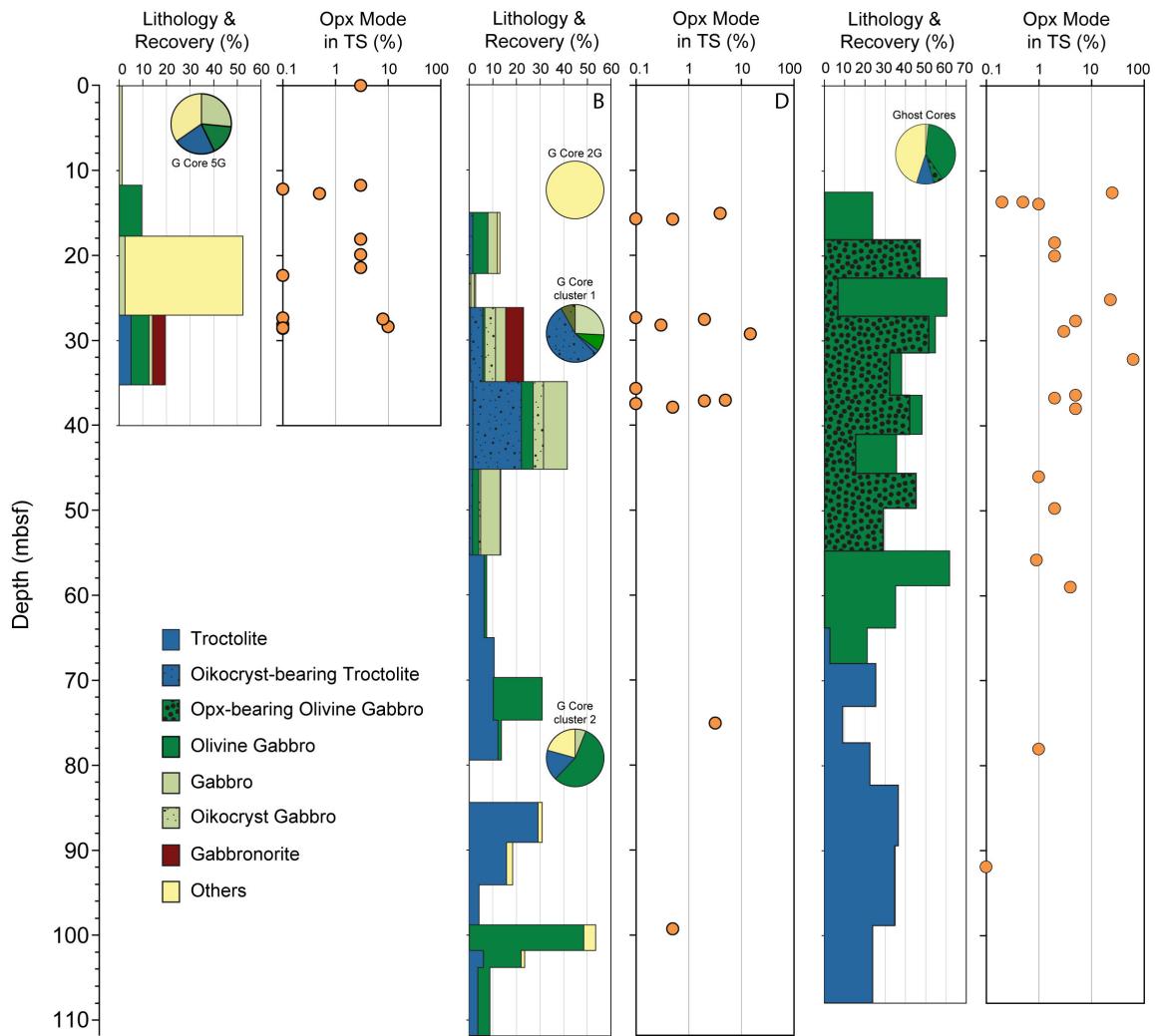


Troctolites



- Medium to coarse grained
- Commonly foliated
- Mg# 81–89

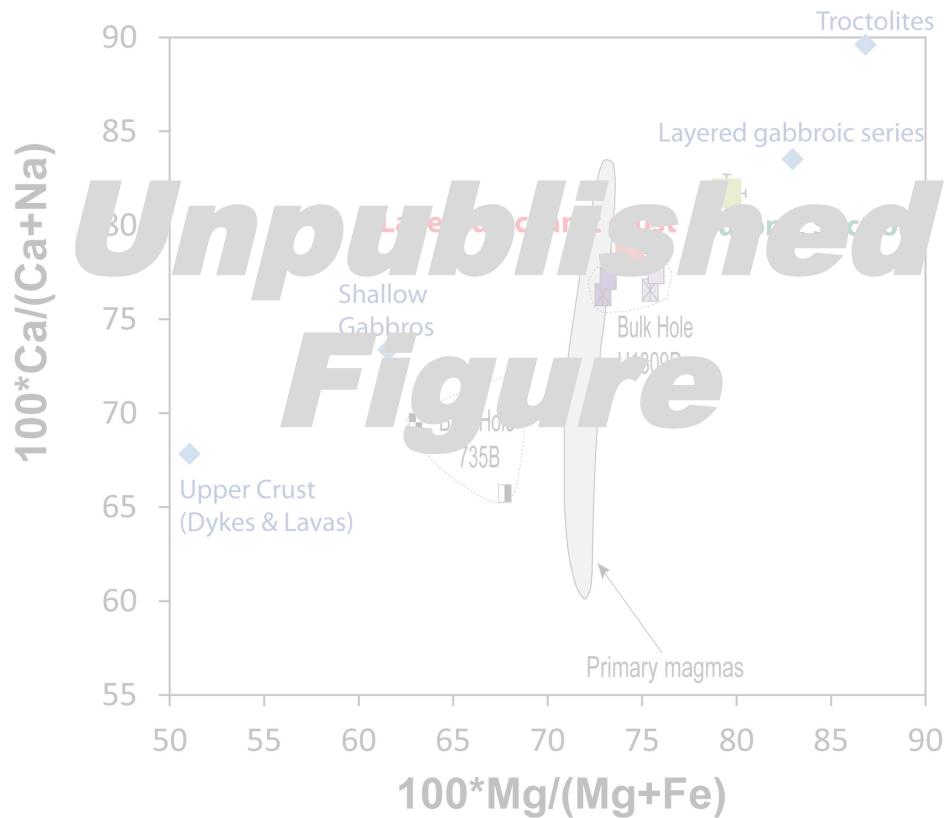
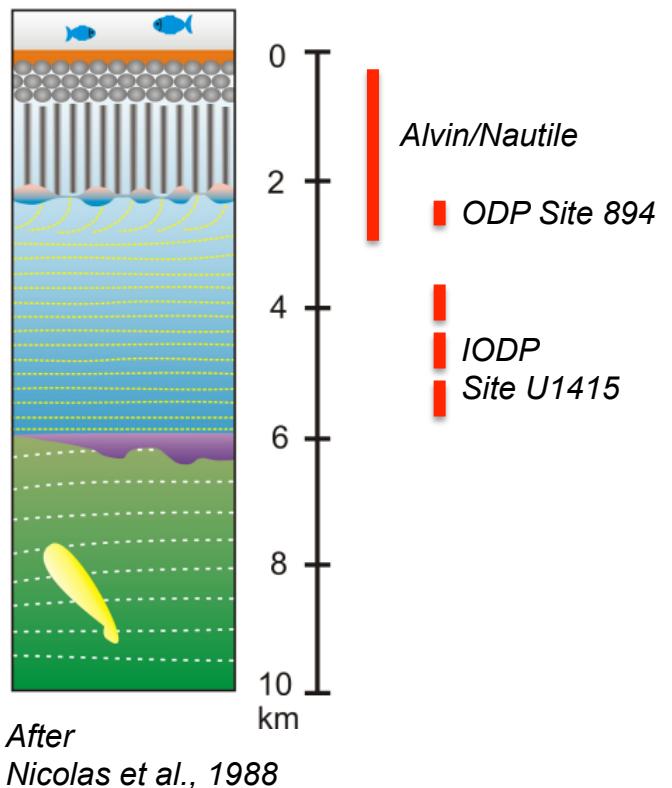
Common Opx-bearing Lithologies



*Early crystallization of Opx (up to 5%)
not expected in primitive gabbros*



Bulk Composition of EPR Crust at Hess Deep



Godard et al., Goldschmidt 2013

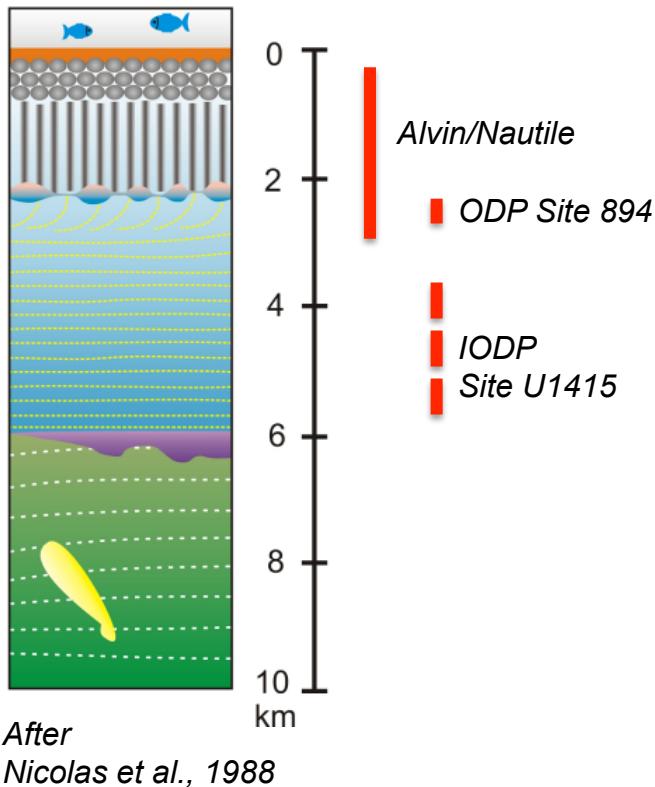
Fast-spread crust : Gillis et al., Nature, 2014

Primary magmas : Kinzler & Grove, JGR, 1993

Hole U1309D : Godard et al., EPSL, 2009

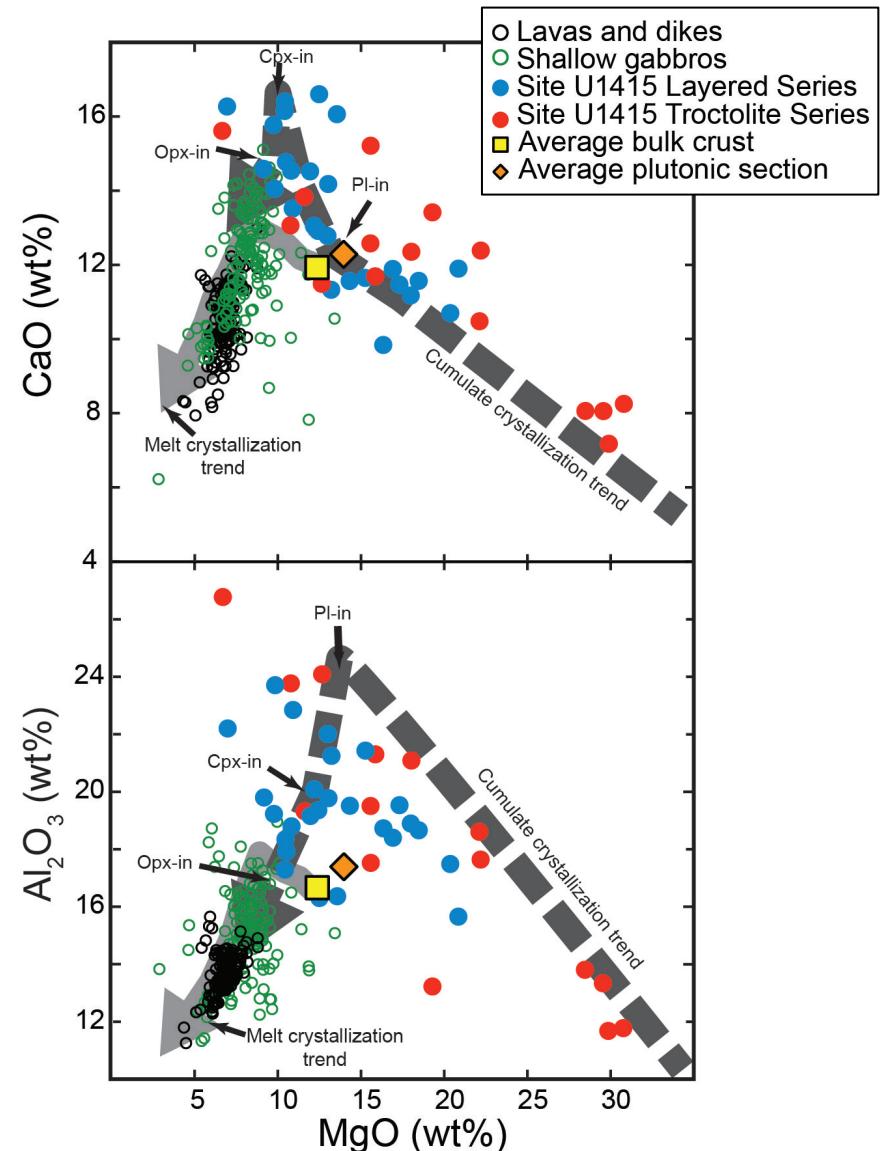
Hole 735B : Hart et al., GCA, 1999; Dick et al., EPSL, 2000

Bulk Composition of EPR Crust at Hess Deep



Consistent with a simple fractional crystallization model for MORB, but...

The presence of orthopyroxene requires a more complex scenario

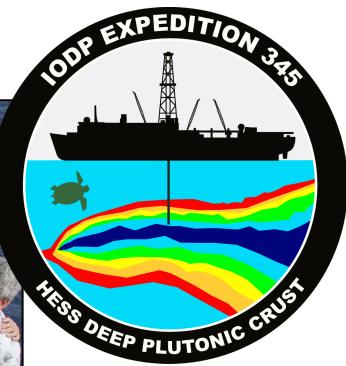


Gillis et al., Nature, 2014

Summary



- IODP Expedition 345 recovered primitive troctolites and layered gabbros from the lower third to half of plutonic crust at the Hess Deep rift (NB: displaced, tilted, discontinuous blocks)
- Variety of layering observed in >50% of recovered core
- Variable intensity of magmatic foliations
- Calculated bulk composition of Hess Deep crust consistent with a simple "Penrose" MORB differentiation model
- Unexpected abundance of cumulus orthopyroxene challenges a simple MORB differentiation model



Summary



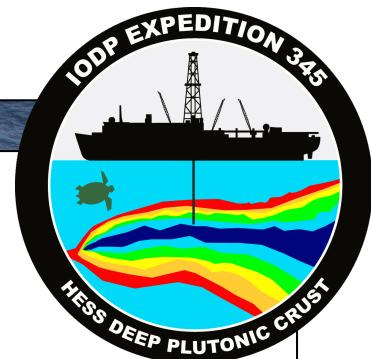
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Poster EGU2014-11744 (Z273)

Petrological characteristics of Opx-bearing primitive gabbros from the East Pacific Rise and the Oman ophiolite

M. Python, N. Akizawa, M. Godard, B. Ildefonse, and J. Koepke



Formation and evolution of oceanic plates PICO Session / Wed, 30 Apr, 08:30 - 12:00
EGU2014-11420

Static and fault-related alteration in the lower ocean crust, IODP Expedition 345, Hess Deep
A. McCaig, K. Faak, N. Marks, T. Nozaka, M. Python, R. Wintsch, Y. Harigane, S. Titarenko and the IODP Expedition 345 Team