Announcements

- Reading for today: p.242-251; p.182-185
- Reading for Fri: p.105-116
- Turn in Field Notes for LV trip on Friday
- Homework 5 is on the web; due May 31

Mantle composition and mineralogy

- What is the composition of the (upper) mantle?
- What mineral phases are stable in the (upper) mantle?
- Why do we care about the answers to the first two questions?

Sources of mantle material

- Ophiolites
  - Slabs of oceanic crust and upper mantle
  - Thrust at subduction zones onto edge of continent
- Dredge samples from oceanic fracture zones
- Nodules and xenoliths in some basalts
- Kimberlite xenoliths
  - Diamond-bearing pipes blasted up from the mantle carrying numerous xenoliths from depth

Composition of the upper mantle

	spinel lherzolites	garnet lherzolites	abyssal peridotites
SiO_2	44.2	46.1	43.6
TiO_2	0.13	0.12	0.02
Al_2O_3	2.1	1.2	1.2
FeO	8.3	7.2	8.2
MgO	42.4	43	45.2
CaO	1.9	0.8	1.1
Na_2O	0.27	0.1	0.02
K_2O	0.06	0.04	0
NiO	0.28	0.29	0
Cr_2O_3	0.44	0.37	0

Come back to this later… mantle melting

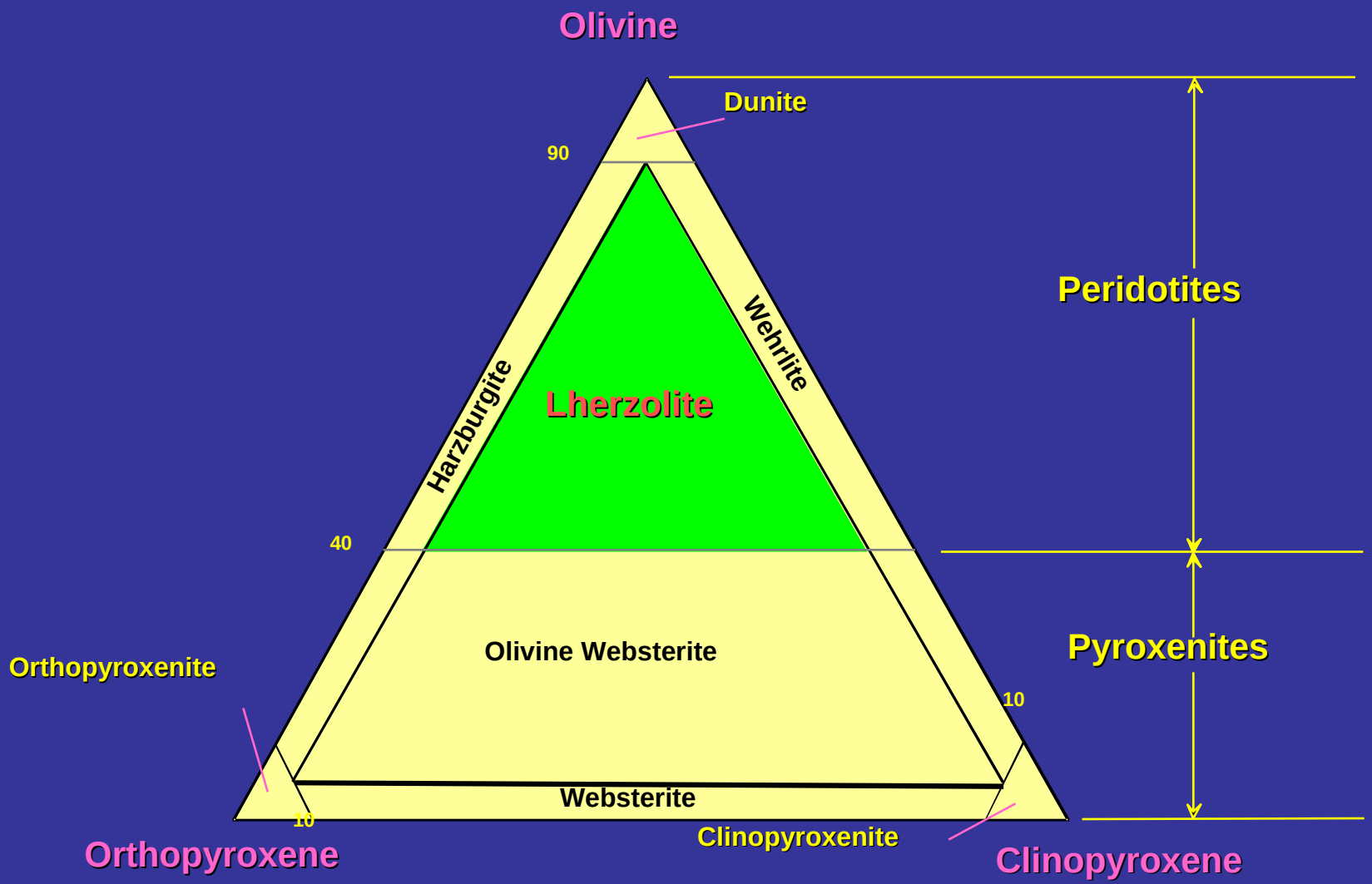
Mantle mineralogy

- What minerals do we see in xenoliths?

Composition of the upper mantle

	Ol	Opx	Di	Spinel	Gt	Plag
Spinel Lherzolites	80	10	8	2		
Garnet Lherzolites	63	30	2		5	
Abyssal peridotites	74.8	20.6	3.6	0.5		0.9

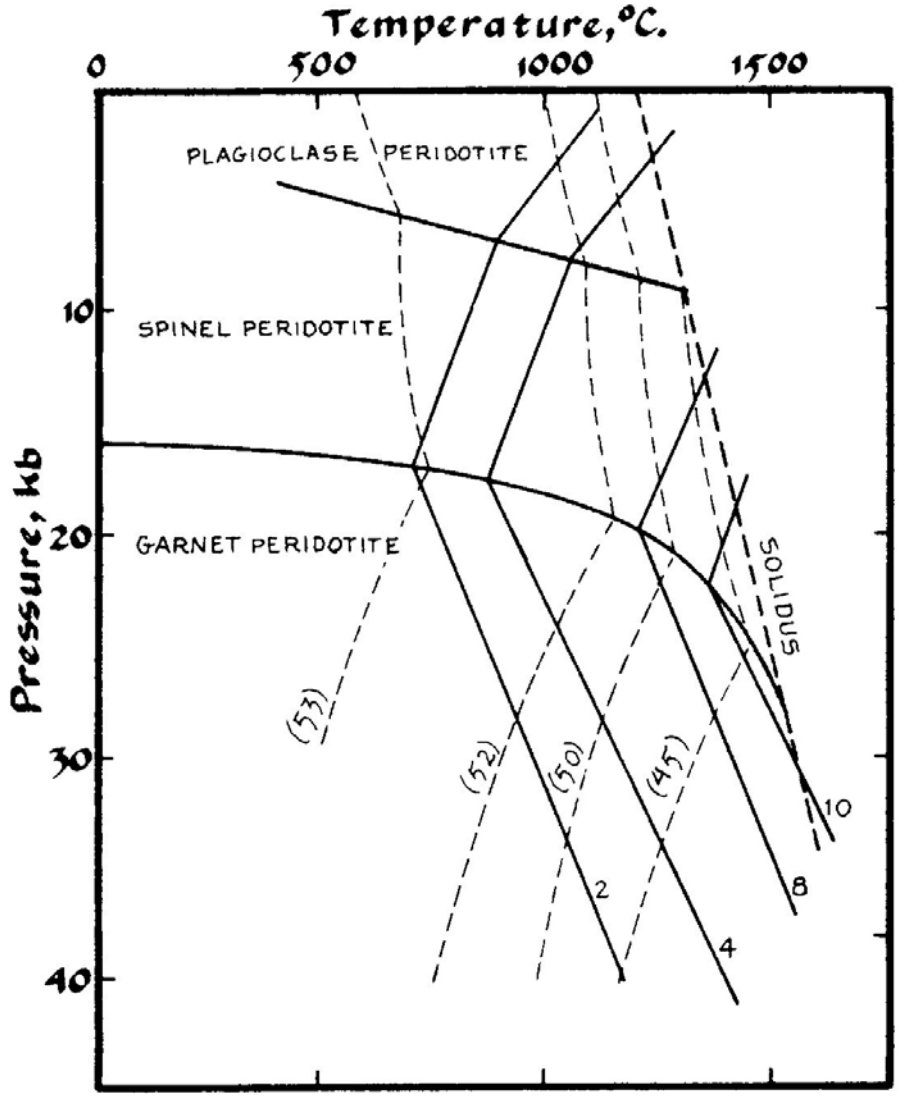
Mantle mineralogy



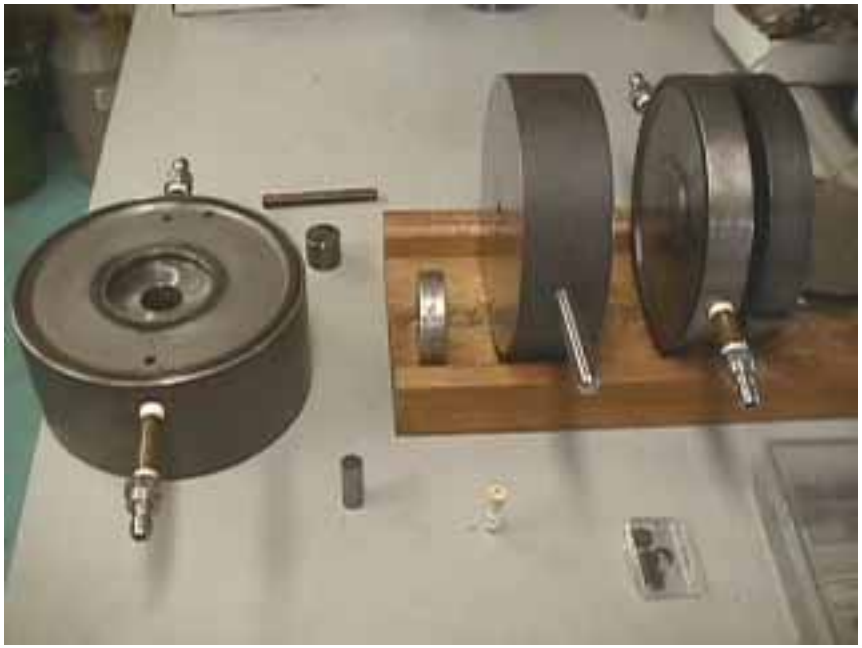
Plag-spinel-garnet lherzolites

- Understanding change in mineralogy with depth
- Density, crystal structure

Anorthite = 2.76
Spinel = 3.55
Pyrope gt = 3.582



Experimental Petrology



Experimental Petrology

- P = F/A
- 3-4 GPa

Oceanic Crust and Upper Mantle Structure

Layer 1

A thin layer of pelagic sediment

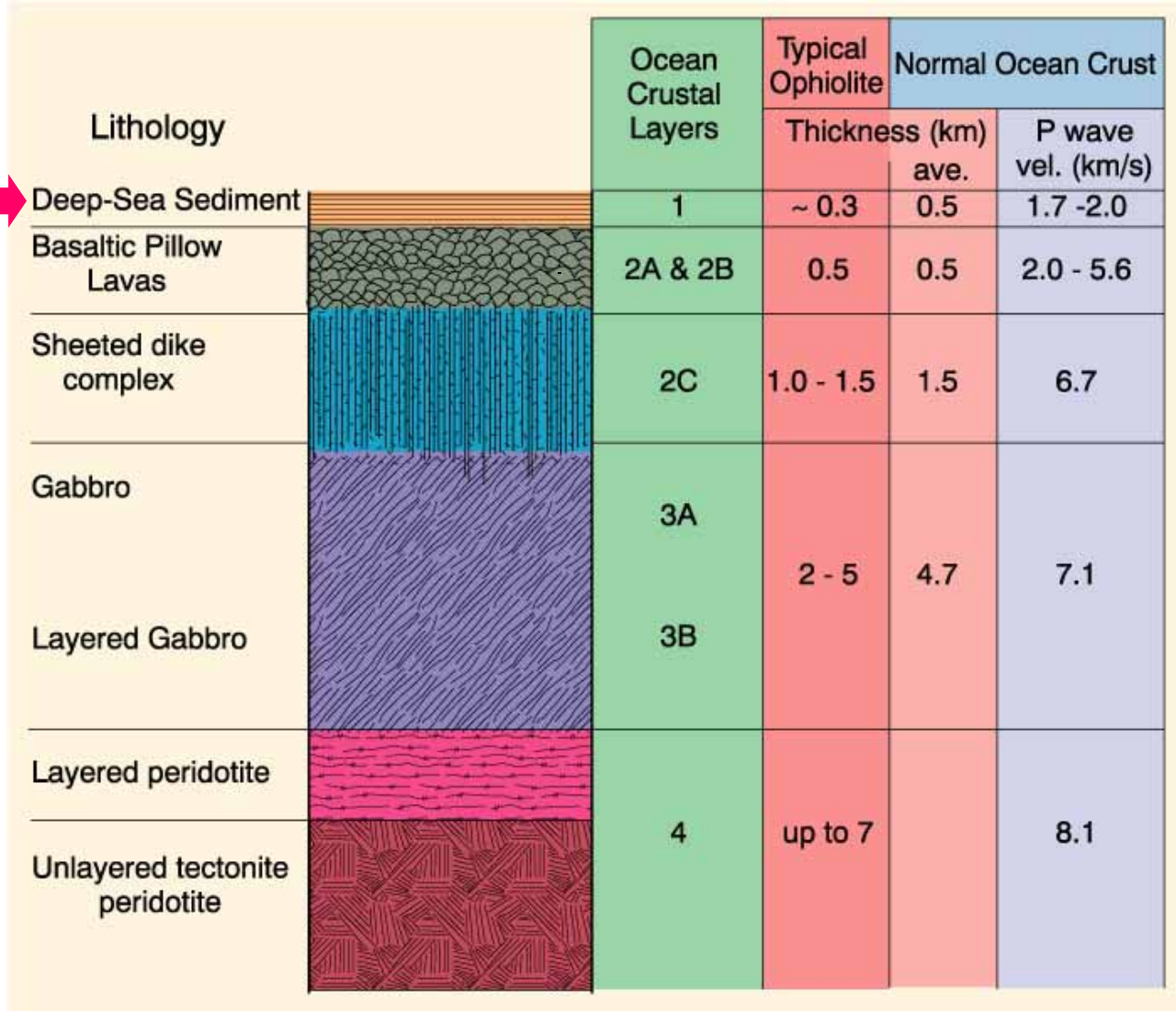


Figure 13-4. Modified after Brown and Mussett (1993) The Inaccessible Earth: An Integrated View of Its Structure and Composition. Chapman & Hall. London.

Oceanic Crust and Upper Mantle Structure

Layer 2 is basaltic

Subdivided into two sub-layers

Layer 2A & B = pillow basalts

Layer 2C = vertical sheeted dikes

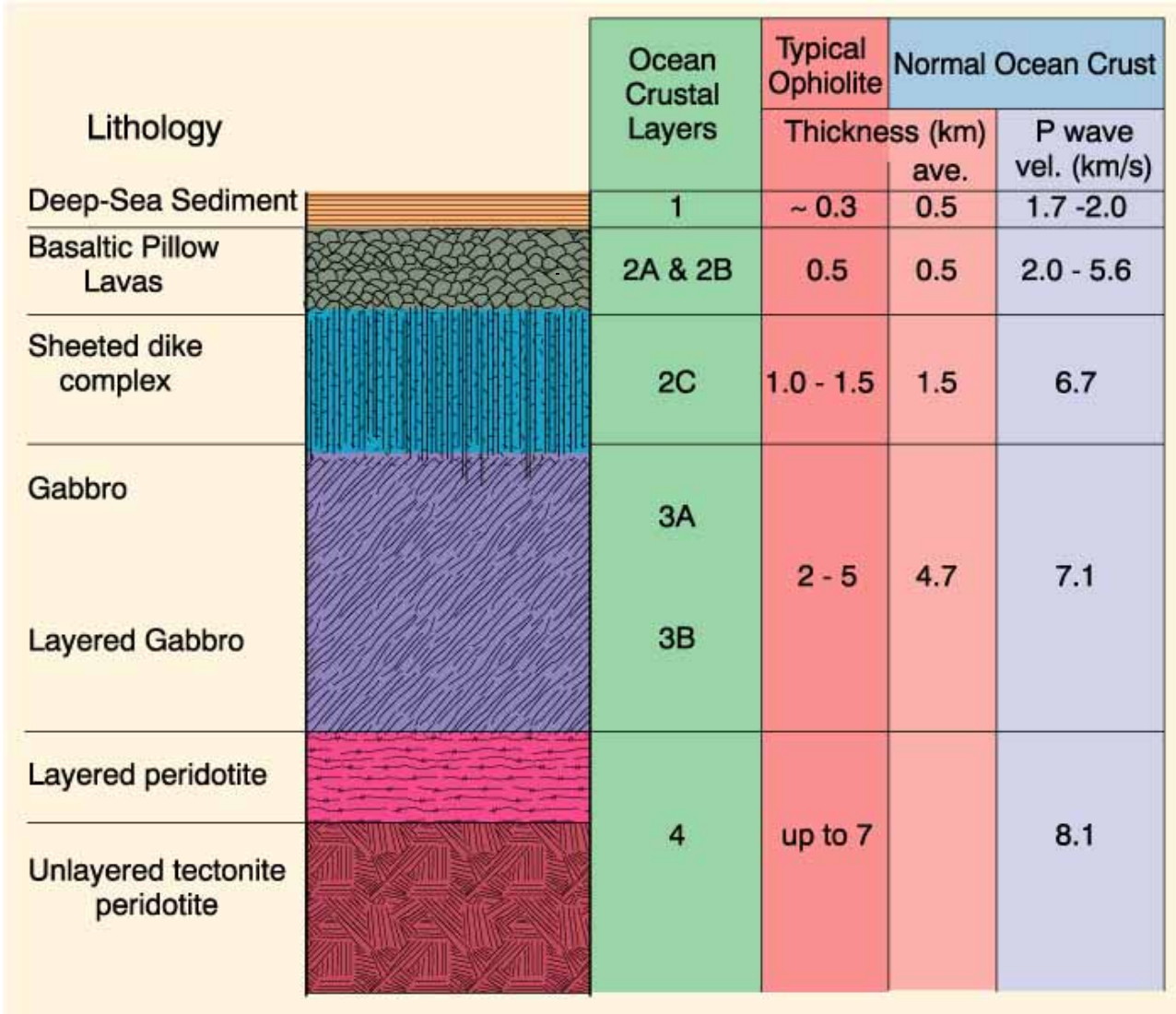


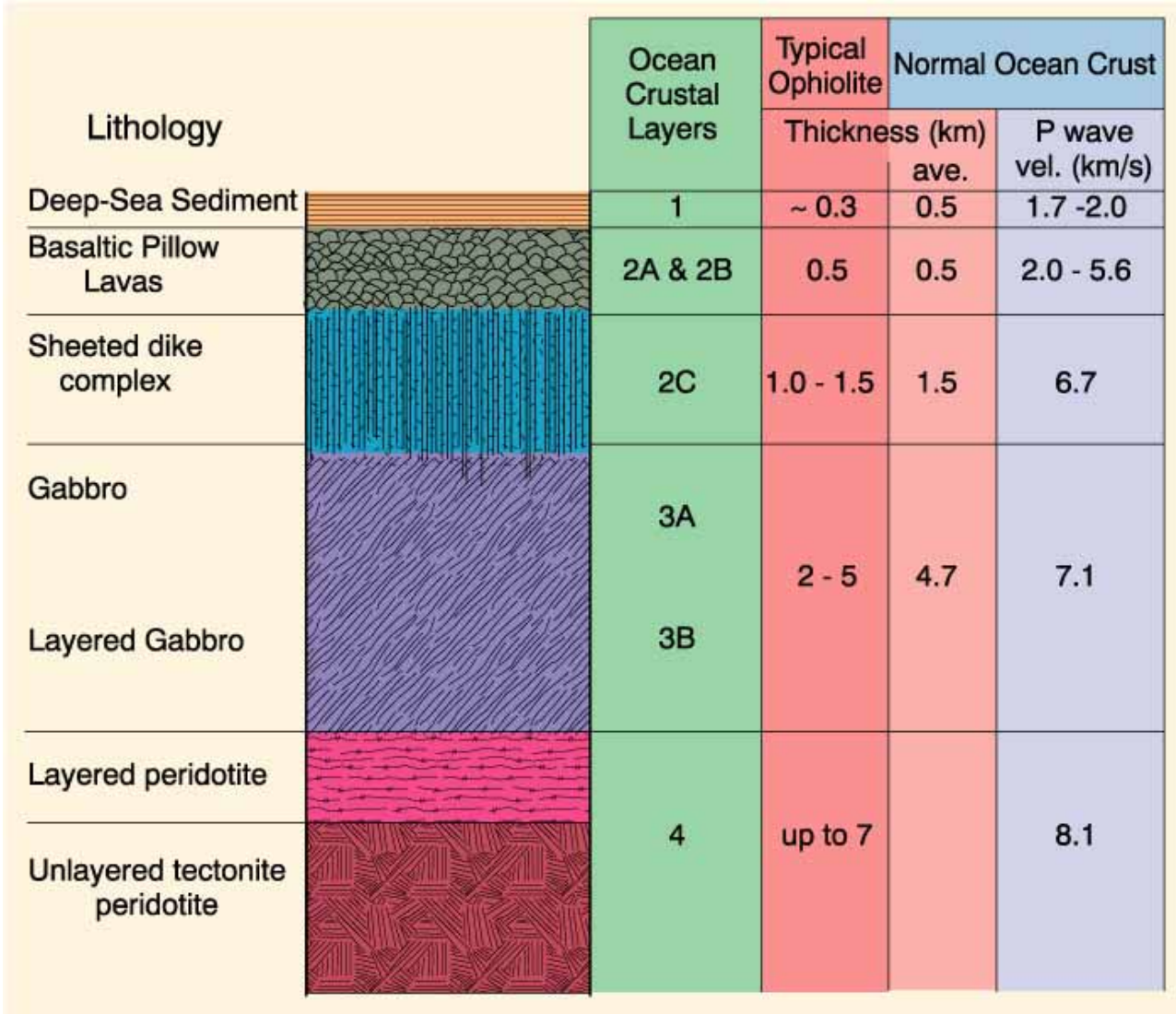
Figure 13-4. Modified after Brown and Mussett (1993) The Inaccessible Earth: An Integrated View of Its Structure and Composition. Chapman & Hall. London.

Layer 3 more complex and controversial

Believed to be mostly gabbros, crystallized from a shallow axial magma chamber (feeds the dikes and basalts)

Layer 3A = upper isotropic and lower, somewhat foliated ("transitional") gabbros

Layer 3B is more layered, & may exhibit cumulate textures



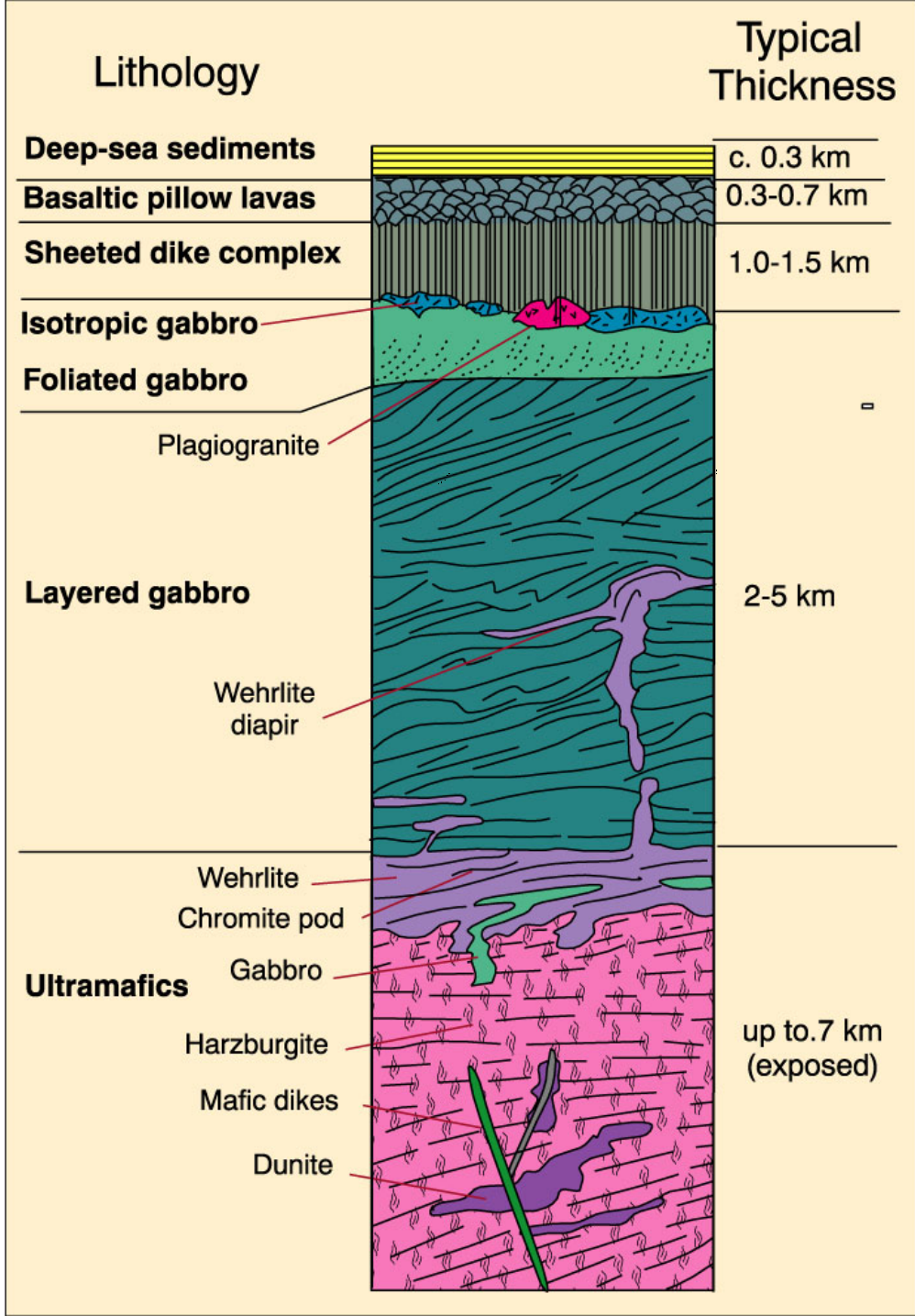
Layer 4 = ultramafic rocks

Ophiolites: base of 3B grades into layered cumulate wehrlite & gabbro

Wehrlite intruded into layered gabbros

Below → cumulate dunite with harzburgite xenoliths

Below this is a tectonite harzburgite and dunite (unmelted residuum of the original mantle)



Summary of important points

- Mantle composition
- Mantle mineralogy
- Experimental petrology
- Ophiolite stratigraphy