

How strong a constraint is the Ar budget on layered convection?

-Not very. We don't know the K abundance of the earth well enough. We need better constraints on composition of continental crust, and amount and composition of subducted crust.

Should we believe the evidence for "core signatures" in Os or W as the smoking gun that plumes come from the CMB?

-No (sorry Rich). The reported "core" Os-isotope signatures (elevated ^{186}Os) seen in some plume-derived melts (Hawaii, Gorgona) can be generated by other mechanisms (pyroxenites, sediments). We are not near consensus here.

-IF Os- and W-isotopes could be shown to correlate in OIBs, we might be closer to a "smoking gun" for core interaction. Unfortunately, the W-isotope signal we expect is $\sim 5x$ smaller than what we can currently measure.

Where are we with radioactive element inventories in the mantle?

Part of the mantle must be less depleted than the source of MORB. However, the size and location of this "enriched" part is not known.

Is upper mantle chemistry a useful guide to lower mantle chemistry?

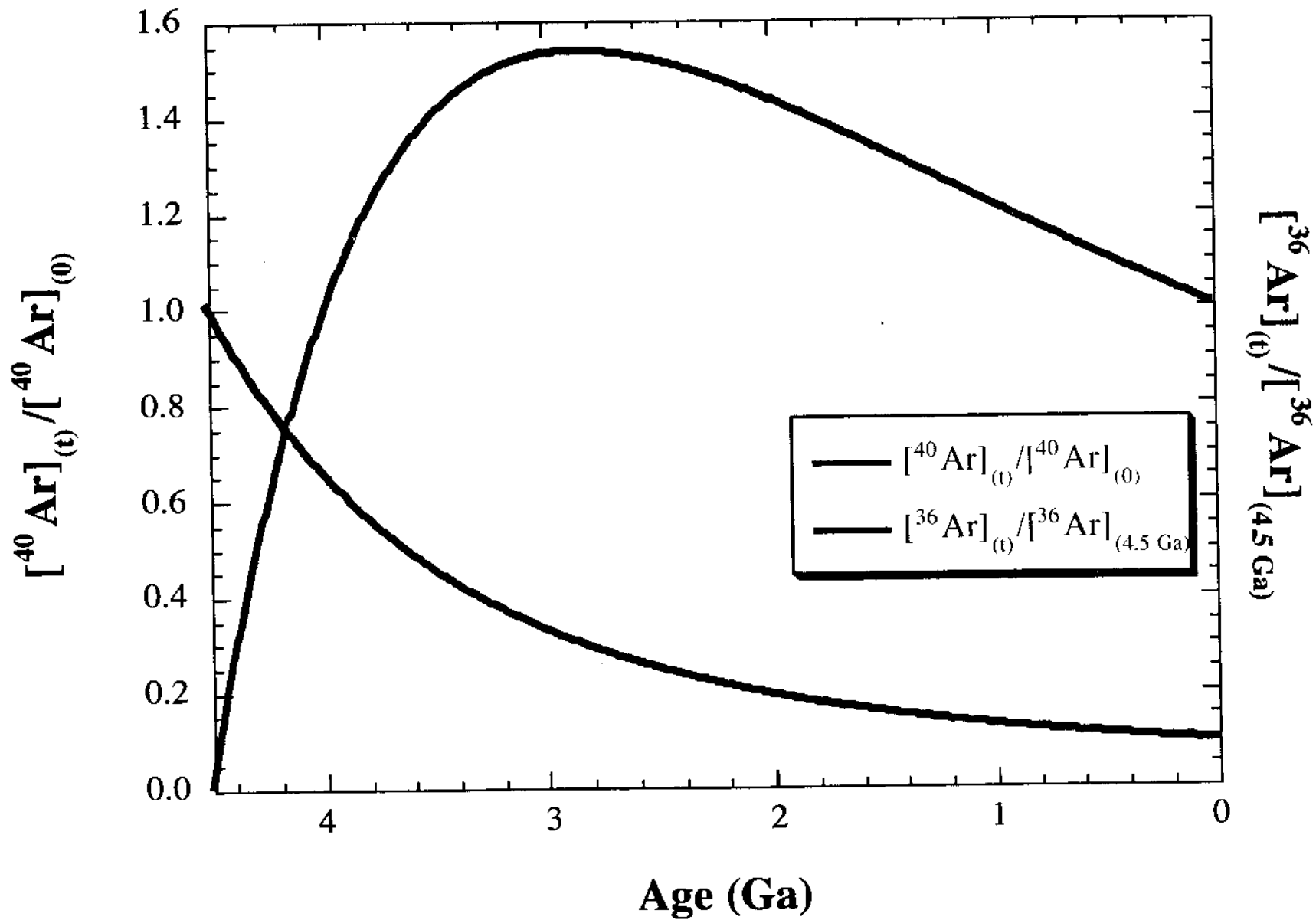
See above.

Would it help if the mineral physics guys could rule out, or in, having K and/or U in the core?

Sequestering U in the core would reduce our estimate of primitive mantle K abundance, and would also provide a heat source for the core.

Placing K in the core would provide an early heat source, but doesn't change the "missing Ar" problem (see below).

Degassing of radiogenic and primordial Ar in the mantle



Geochemical arguments for mantle layering:

1) Lithophile tracers (e.g., Sr, Nd)

Parts of the mantle must be less depleted than the source of MORB
Size and location of this less-depleted reservoir is unconstrained.
The smaller this reservoir is, the more enriched it must be.

2) "Primitive" noble gas isotopic signatures (e.g., He, Ne, Xe)

Parts of the earth have lower (U+Th)/X ratios than MORB source.
Size and location (mantle? core?) of this reservoir is unconstrained.
Whether this reservoir is gas-rich or U- and Th-poor is unconstrained.

3) "Missing Ar" Argument

Potentially provides the only strong constraint on the size of the less-depleted reservoir (~50% mantle mass).
Necessary starting assumptions (K abundance in silicate earth) are much poorer constrained than we pretend.

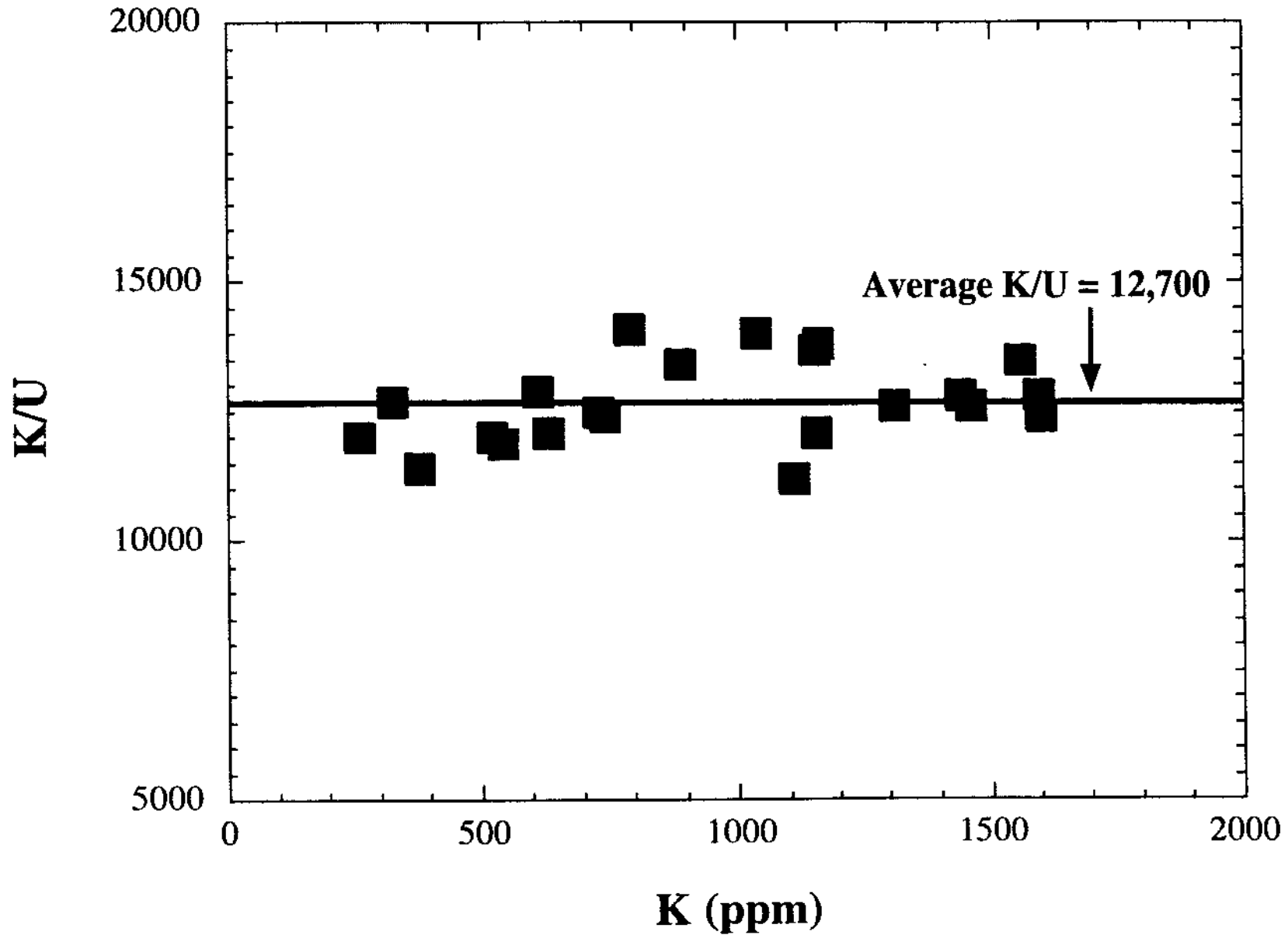


Combined $T_{1/2} = 1.28 \text{ Ga}$

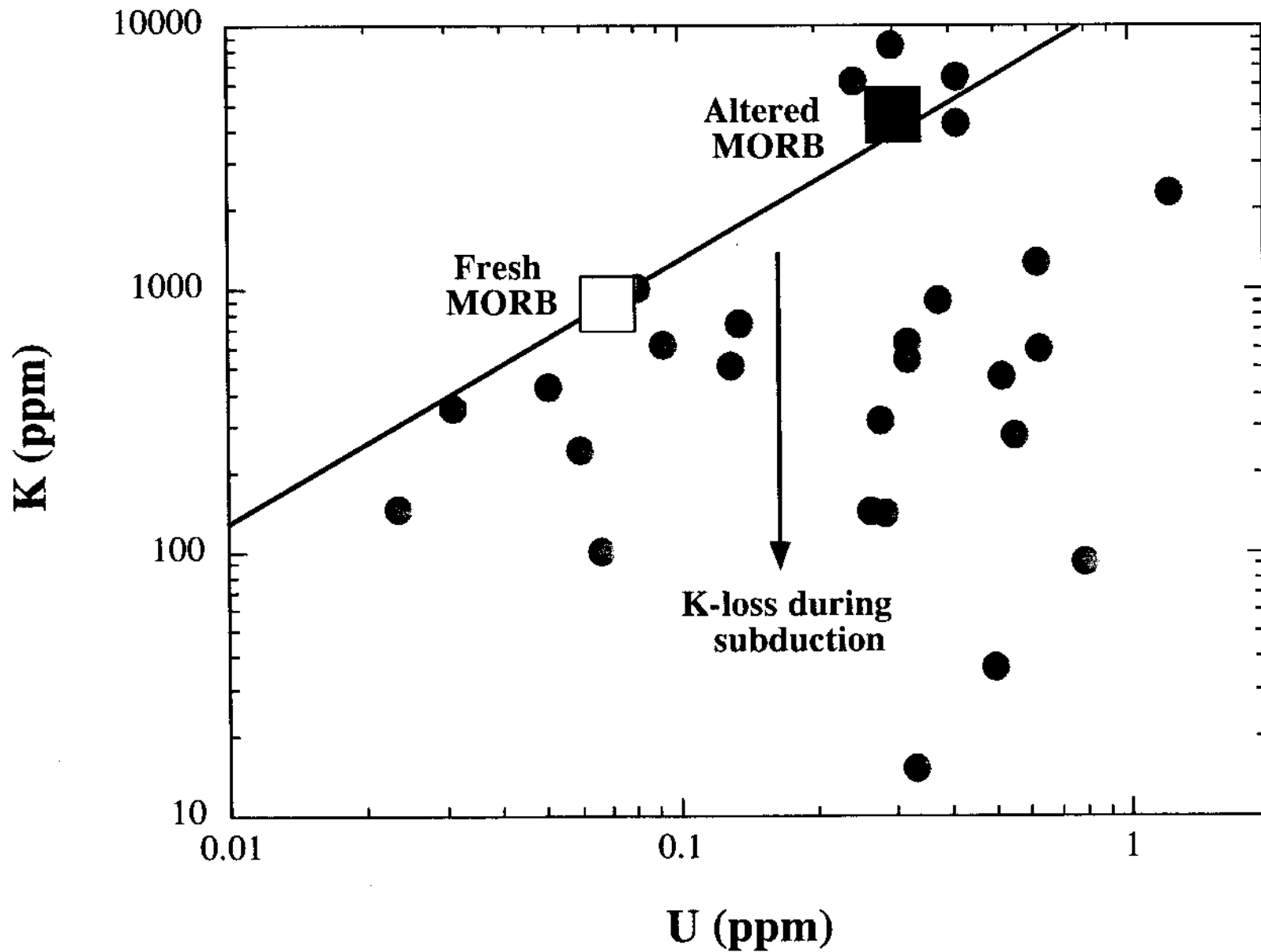
If we know how much potassium the earth contains, we can compare the quantity of ^{40}Ar produced over earth history with the quantity of ^{40}Ar in the atmosphere to constrain the extent of mantle degassing.

How well constrained is the bulk silicate earth potassium content or K/U ratio?

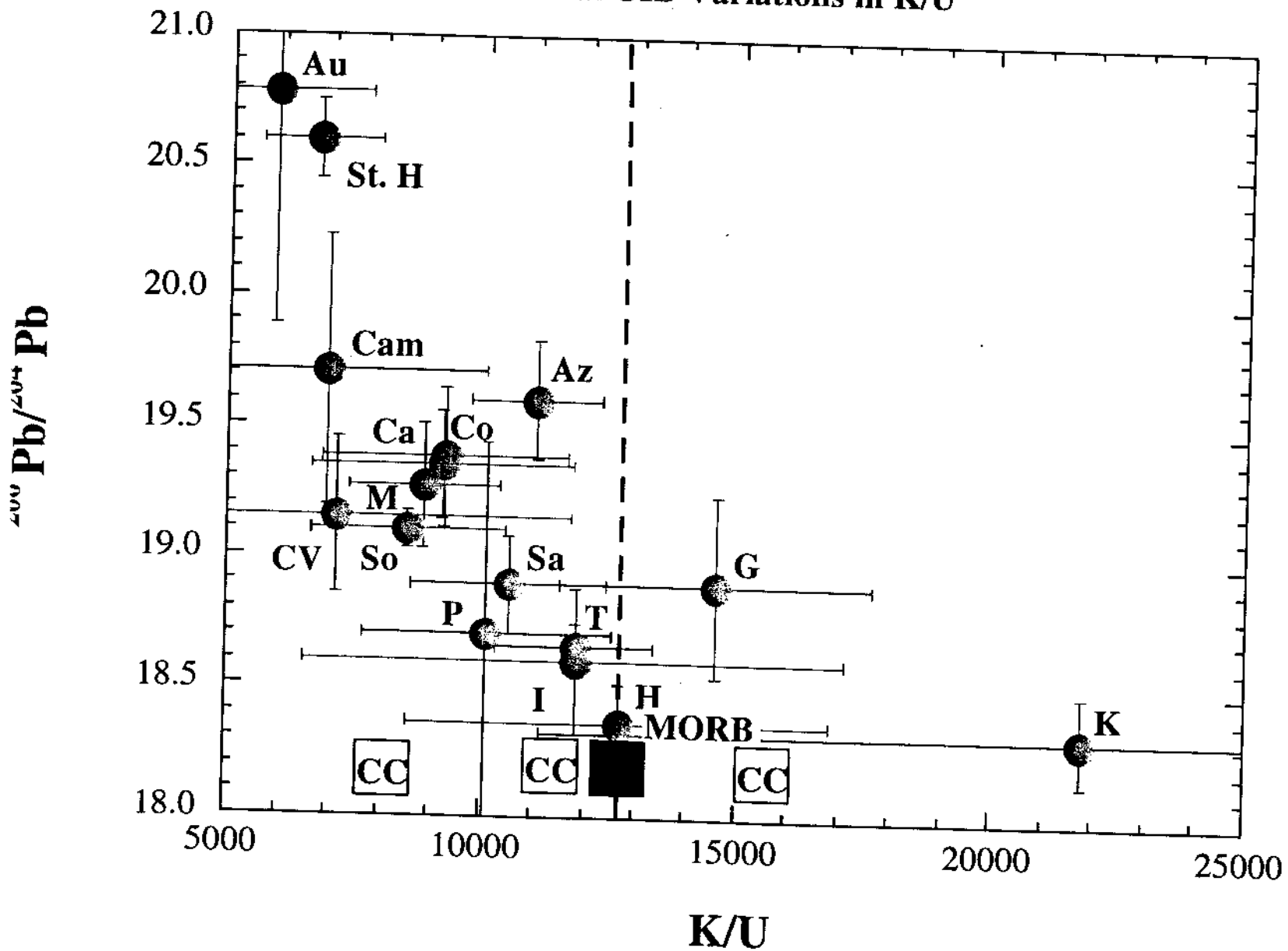
K/U in MORB (Jochum et al., 1983)



K and U abundances in eclogites and MORB (Becker et al., 2000)



Global OIB Variations in K/U



Stan's Questions (to be answered in 8 min. or less)

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K and Ar distribution within the silicate earth

	Mass fraction of silicate earth	[U] (ppm)	[K] (ppm)	K/U	Mass ^{40}Ar (10^{15} kg)	% ^{40}Ar
Continental crust	0.006	1.3	14900	11400	5-10	5-10
Sub-continental lithospheric mantle	0.049	0.04	232	5810	~1-2	~2
Depleted mantle	0.883	0.004	50	12700	15-21	16-22
Recycled oceanic crust	0.062	0.117	293	2500	~2	~2
Atmosphere					66	~70
Bulk silicate earth		0.021	170	8040	95	

Common Misconceptions

- 1) The extent of ^{40}Ar degassing ($\sim 50\%$) is a firm constraint on geodynamic models.
- 2) Total heat production in the earth is a free variable. We can increase it above ~ 20 TW to achieve a reasonable Arey ratio.

How do we distinguish between

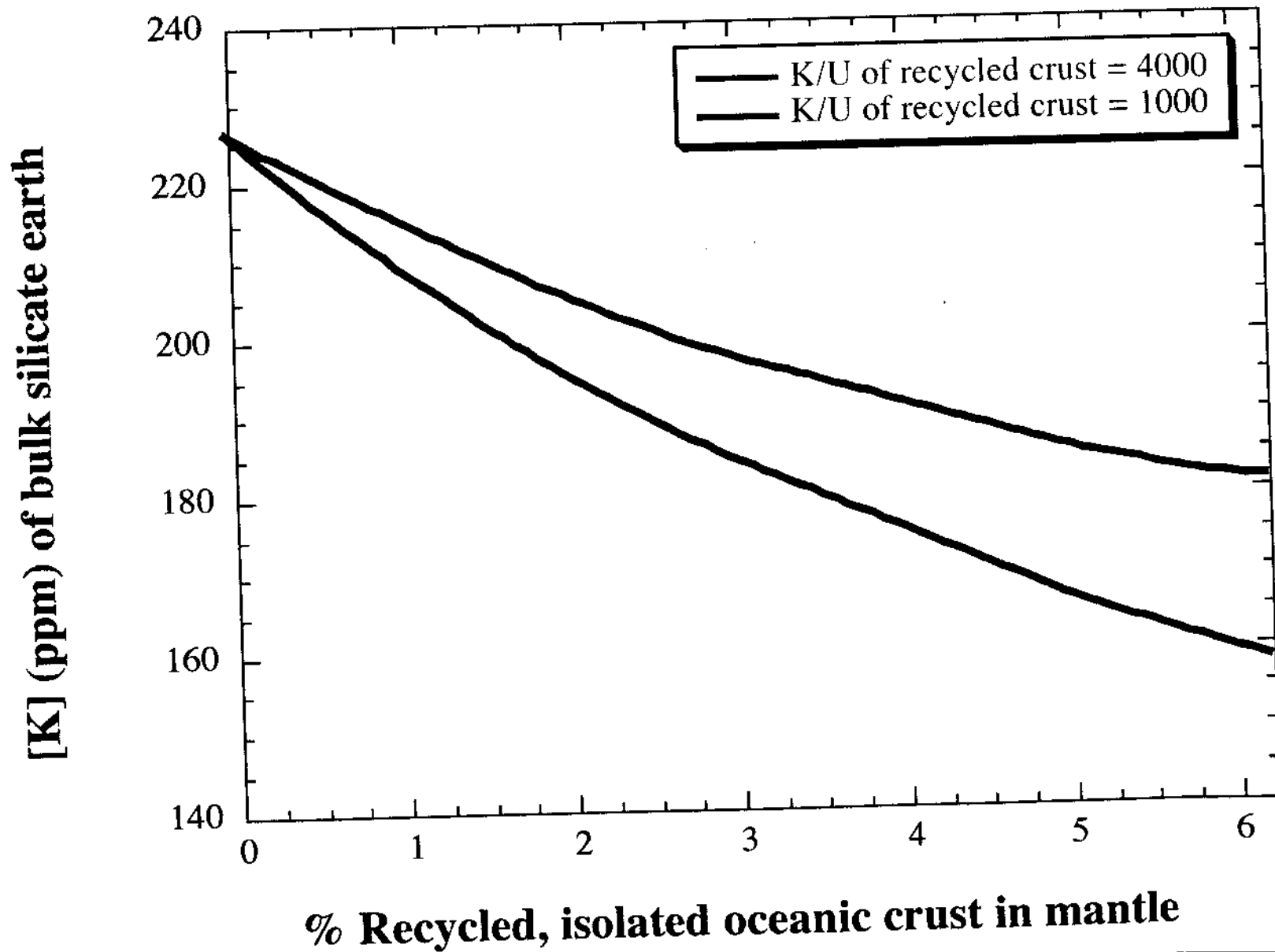
1) hard constraints,

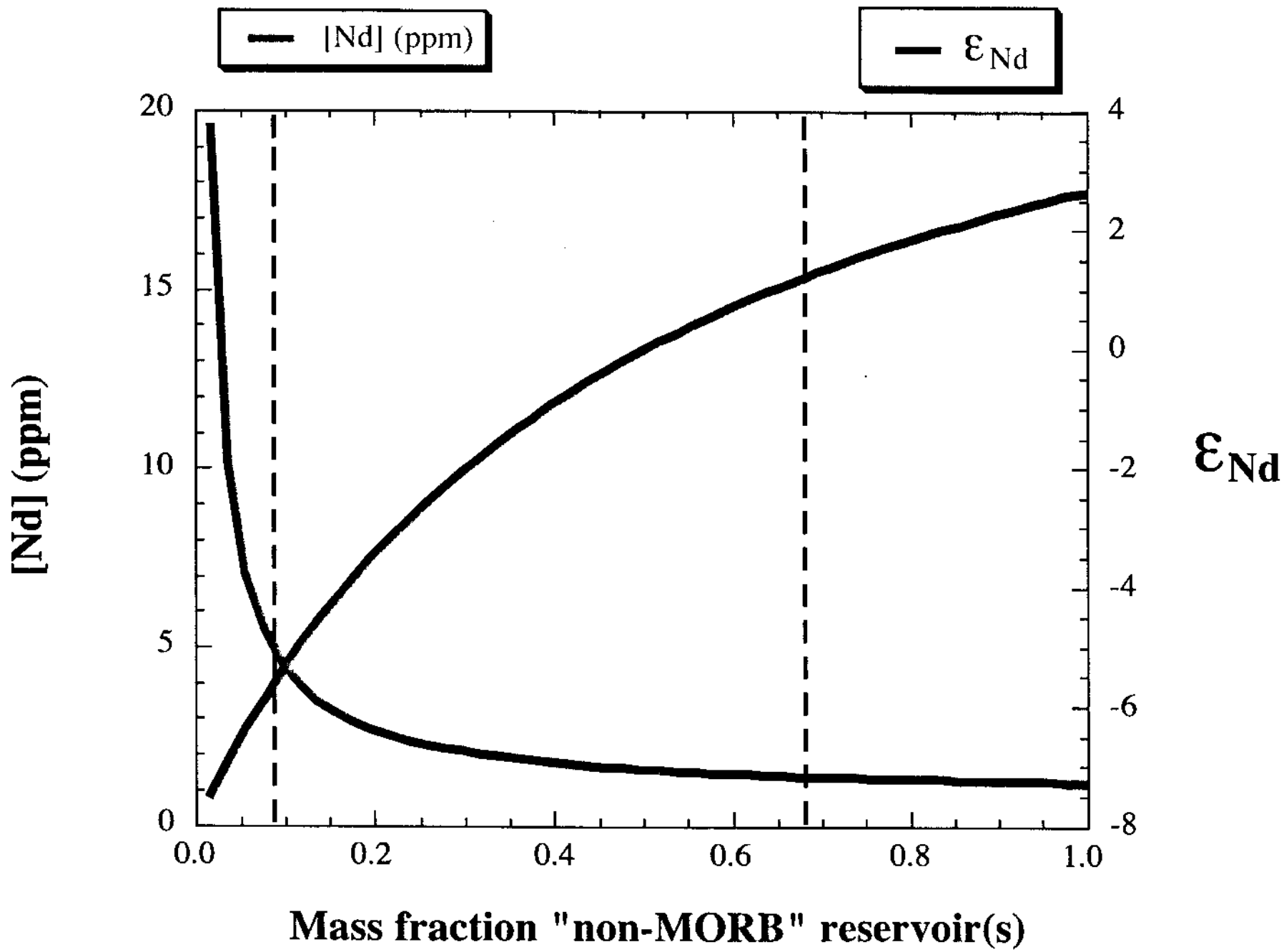
2) soft constraints, and

3) myths and wishful thinking

in fields outside our own expertise?

Effect of recycled crust on BSE [K] estimate





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