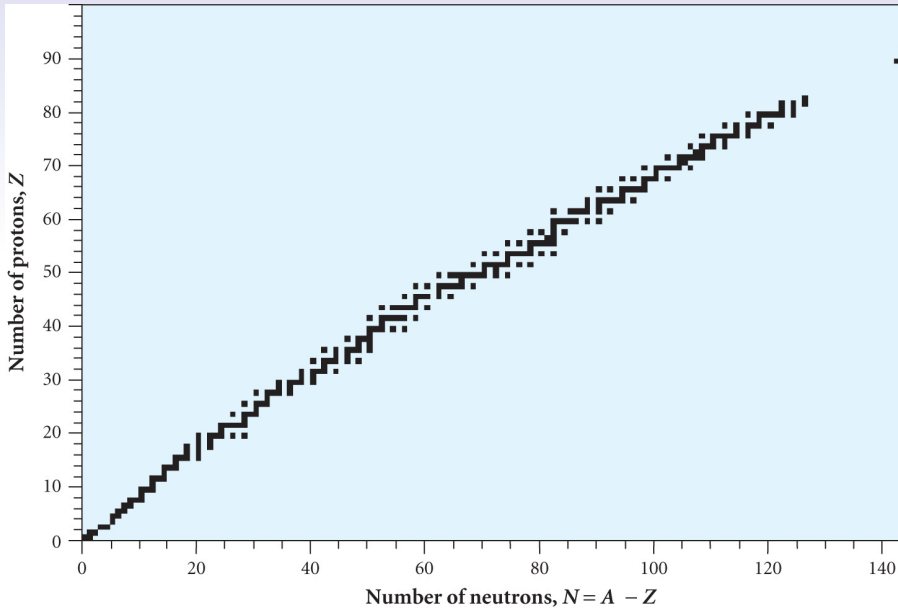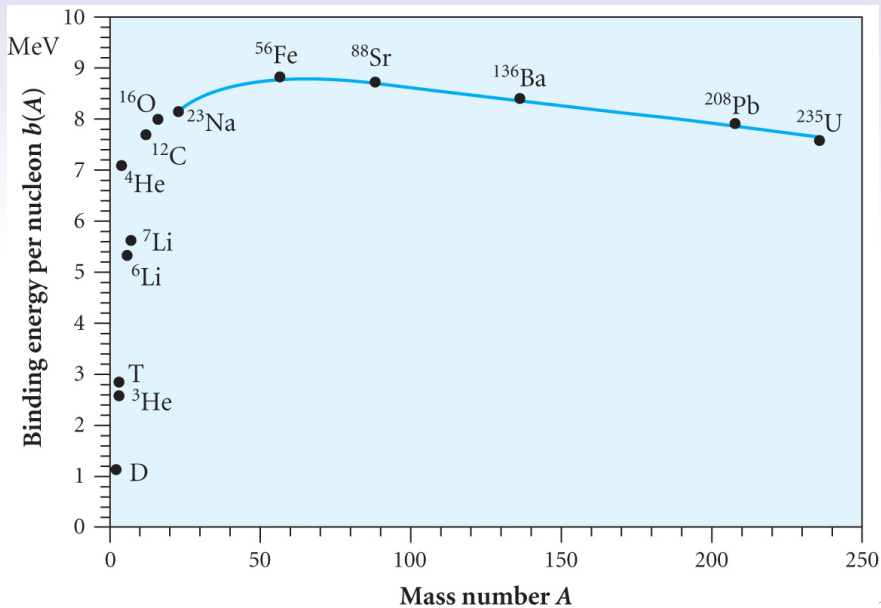# Nuclear Energy

PEN : Lectures Week 10
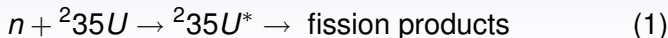
Binding energy

Binding energy

TOPICS in Nuclear Fission

- ▶ Def. Binding energy ; The binding energy per nucleon curve ; Calculation of energy released in fission of ^{235}U.

- ▶ The energy barrier. Tunelling. The reaction

$$n + {}^{2}35U \rightarrow {}^{2}35U^{*} \rightarrow \text{ fission products} \qquad (1)$$

The energetics of this reaction. Krane and AJ (compare 238 and 235 in this respect).

- ▶ Cross-section. Definition. Classical model. Using formula for reaction rate per unit volume. Macroscopic cross-section. neutron flux.

- ▶ Nuclear Reactors. Moderators. Average energy 2 MeV of fast neutrons released in initial fission (See Graph in Fig. 13.13 of Krane). Graphs of x-sections for neutron-induced fission of ^{235}U as a function of energy from $1 - 2$ MeV down to fractions of an eV. Temp. of reactors e.g 500 K for PWR. Thermal neutrons around $0.5 eV$.

- ▶ Calulation related to moderation. Formula for energy lost in elastic scattering. Deriation.

- ▶ Types of Nuclear Reactors. PWRS, BWRs. Other modern designs. Breeder Reactors.

- ▶ Nuclear Waste. Definitions of HIgh level, intermediate and low level waste. Biological effects of radiation.

- ▶ The Oklo natural nuclear reactor. Calculation of lifetimes. Estimate of the 2 billion years.

Pressurized water reactor
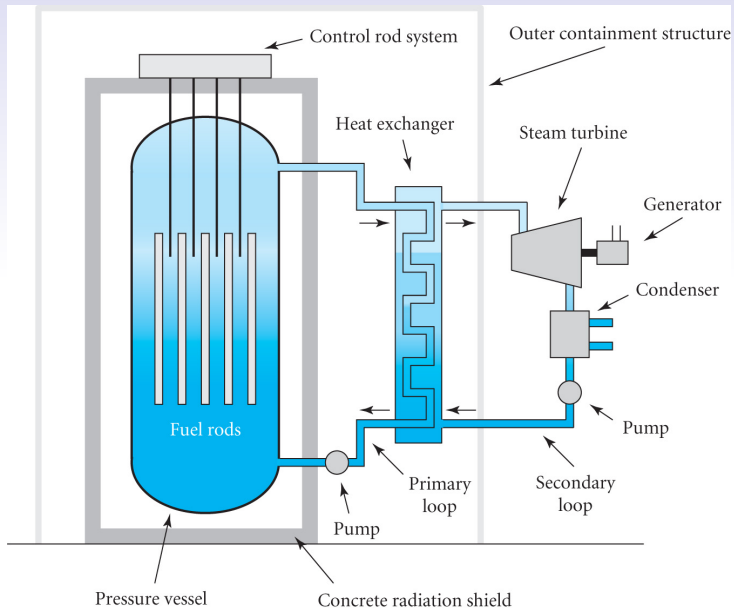
Natural nuclear reactor
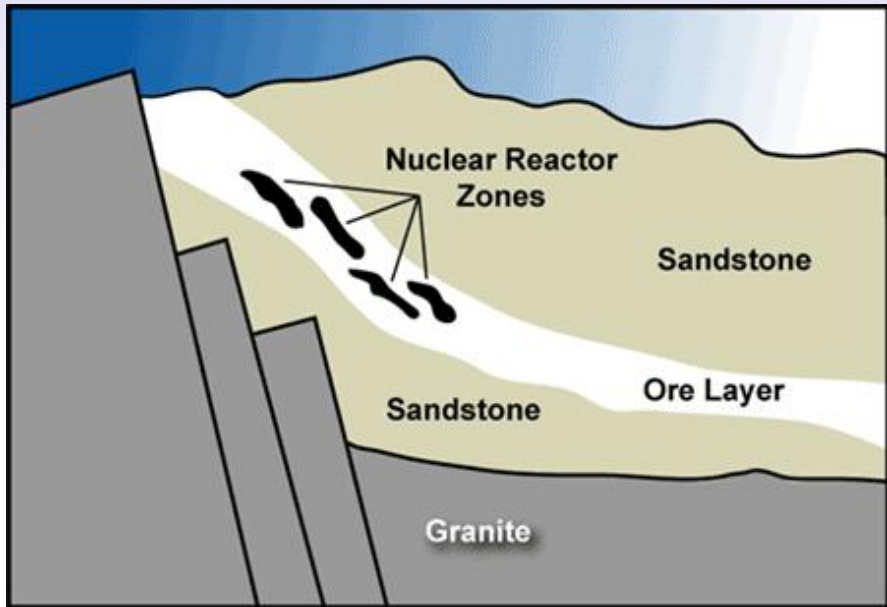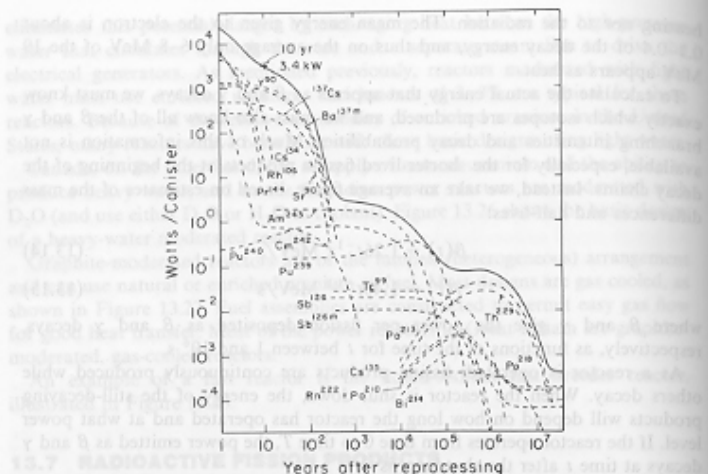
Waste lifetimes

Figure 13.30 Radioactive power produced from decays of fission products and actinides. This amount of power would result from the waste products of a 1000-MW power reactor operating for about one month. The solid curve is the sum of the contributions of the individual isotopes. From B. L. Cohen, *Rev. Mod. Phys.* 49, 1 (1977).

Figure:

Relative Uranium Abundances

Figure 13.30 Radioactive power produced from decays of fission products and actinides. This amount of power would result from the waste products of a 1000-MW power reactor operating for about one month. The solid curve is the sum of the contributions of the individual isotopes. From B. L. Cohen, *Rev. Mod. Phys.* 49, 1 (1977).
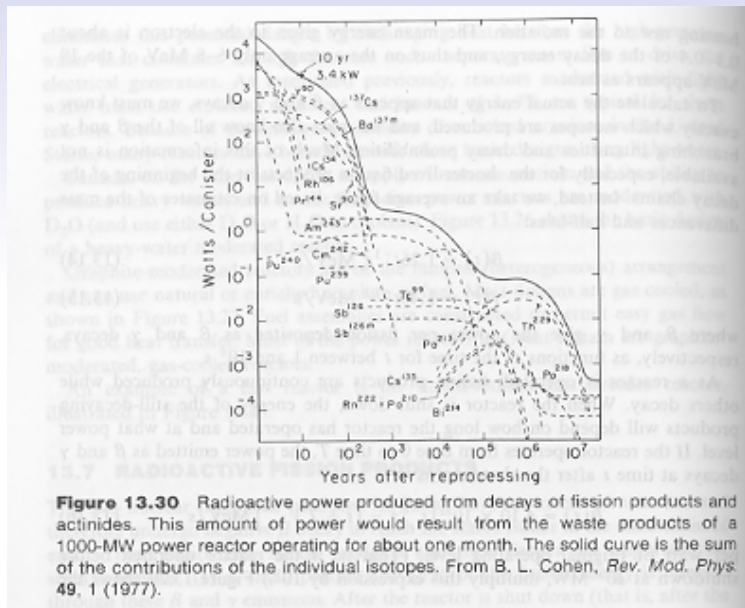
Figure:

Waste lifetimes

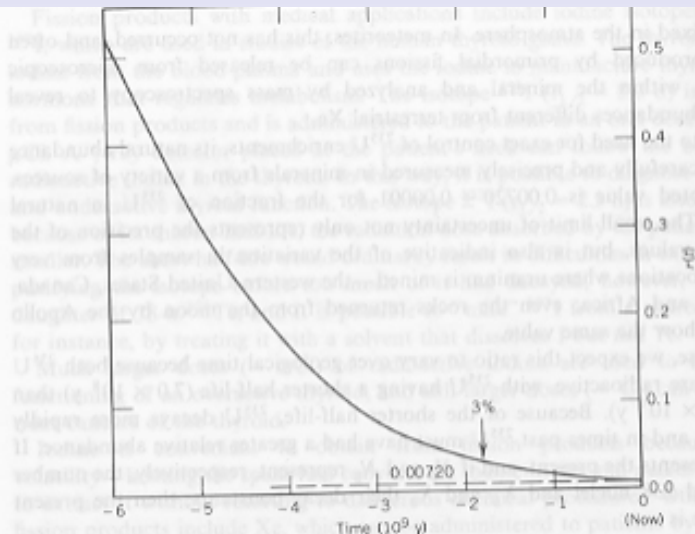**Figure 13.32** Fraction of ^{235}U in natural uranium. The present fraction is 0.00720 and 2×10^9 y ago it was about 3%.