

Some preliminary comments on biosphere modelling in SR-site

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1. General approach
2. Pathways
3. Values of parameters
4. Uncertainty analyses

- * impressively detailed documentation
- * simulations & choice of parameter values partially based on very detailed site-specific analyses
- partially (crude) assumptions
- ⇒ imbalanced modelling: specific / generic
- ⇒ assumptions not always have been justified

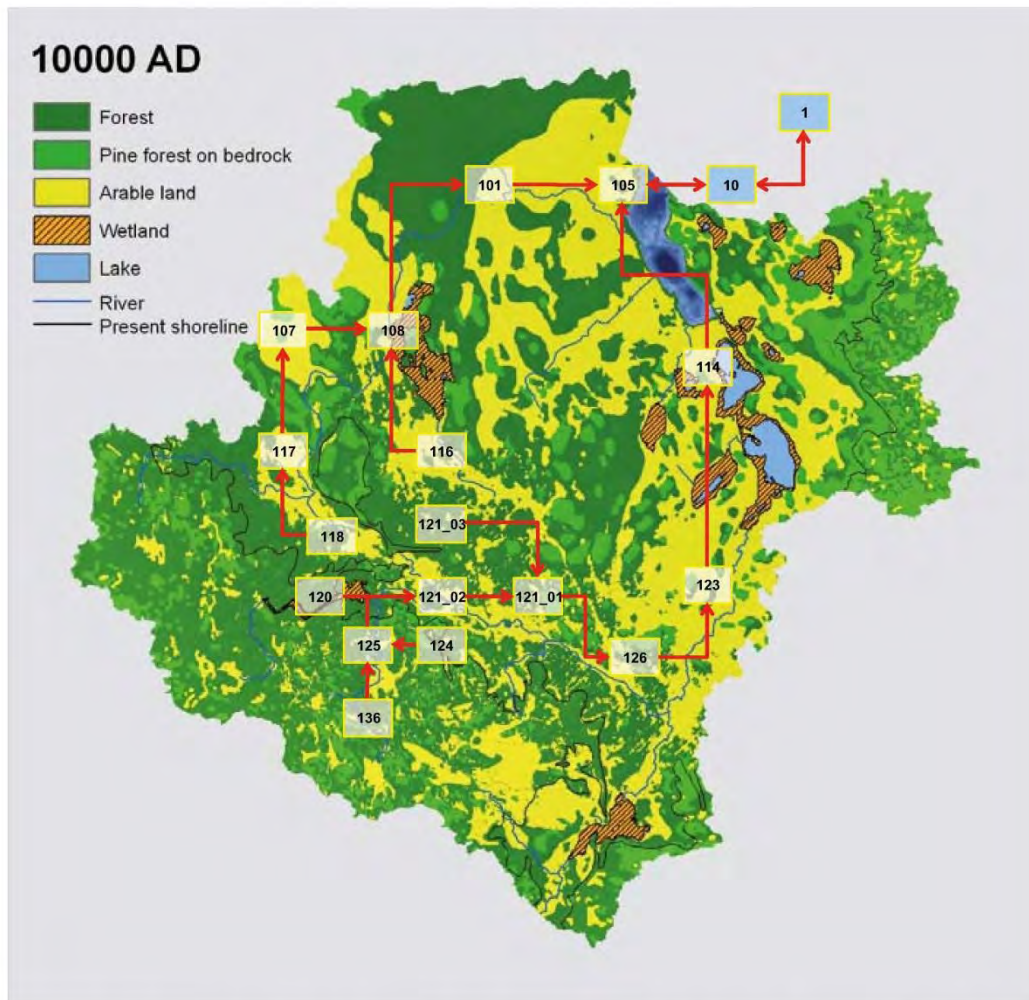


Figure 3-2. Illustration of the landscape model at 10,000 AD. The boxes shows biosphere objects (with id numbers) at their approximate locations in the landscape and red arrows indicate the surface water flow paths connecting the objects. The blue boxes represent the combined objects of Öregrundsgrepen (object 10) and the model area outlet, the Baltic Sea (object 1). Figure taken from /Lindborg 2010/.

The need of drinking water of future human inhabitants living in a biosphere object is assumed to be satisfied by equal contributions from a well drilled into the rock and from the surface water in the lake or stream passing through the object. This also covers the case of drinking water from a shallow well dug into the till, since lake and stream water is likely to intrude into a well that is in contact with contaminated sediments beneath the wetland.

Exposure from contaminated drinking water is considered from the point in time when a biosphere object has emerged from the sea. Livestock are assumed to consume water from the same sources as human inhabitants, i.e. equal water contributions from surface water and a drilled well.

3.2.3 Exposure from food consumption

Doses due to food ingestion (Sv/y) are calculated for each food type by multiplying the activity concentration in food (Bq/kg C) with the food ingestion rate (kg C/y), and the Dose Coefficient for ingestion (Sv/Bq). No assumptions have been made regarding food preferences of future individuals. Instead, in the calculation of food ingestion doses it is assumed that the human diet reflects the production capacity of different foods in the biosphere objects.

Further, it is assumed that future human inhabitants will be self-sustaining and will utilize all available food sources in proportion to their production. The production capacity of human food in a biosphere object is directly determined by the size of the contaminated object, (i.e. the size of the sea basin or the size of the wetland and the surface water), and the sustainable yield of natural food stuffs and agricultural products, which in turn may vary with climatic conditions. Assuming that food production is the limiting factor for humans living in the biosphere object, the number of individuals that can be sustained in a biosphere object is thus proportional to the area of the object. However, the size of the population that can be sustained also depends on land use, since the productivity per unit area of crop is two to three orders of magnitude larger than the productivity of natural food stuffs in a wetland.

All types of food sources from both aquatic and terrestrial parts of a biosphere object are considered in the dose calculations. It is assumed that wetlands will at least partly be converted to agricultural land when this is possible. Thus, when the object is submerged the human diet consists of sea food. When the object has been isolated from the sea, the diet consists of natural food stuffs from the lake/stream and from the wetland. When agriculture is possible, the diet will be a combination of natural food stuffs and agricultural produce. The contribution of each food type to the human diet is assumed to be proportional to the production of that food type in the object. When agriculture is possible, it is deemed equally likely that the wetland is used for production of natural food stuffs, cereals, root crops, vegetables or fodder for beef and dairy production.

The result is that biosphere objects with a large area that can be drained and cultivated can typically feed a population in the range of 170–1,300 persons (first and third quartiles, respectively). In contrast, biosphere objects that cannot be cultivated can only support a limited number of individuals, i.e. approximately 10 individuals during submerged or coastal conditions and typically one or a few individuals when inhabitants are limited to forage the lake and wetlands for natural food stuffs. It is important to note that the assumption of self-sustained future inhabitants of the area does not imply that this is a “stone-age”-like culture. It only sets the constraint that the population is obtaining all its food locally from available resources.

* LDF figures difficult to interpret

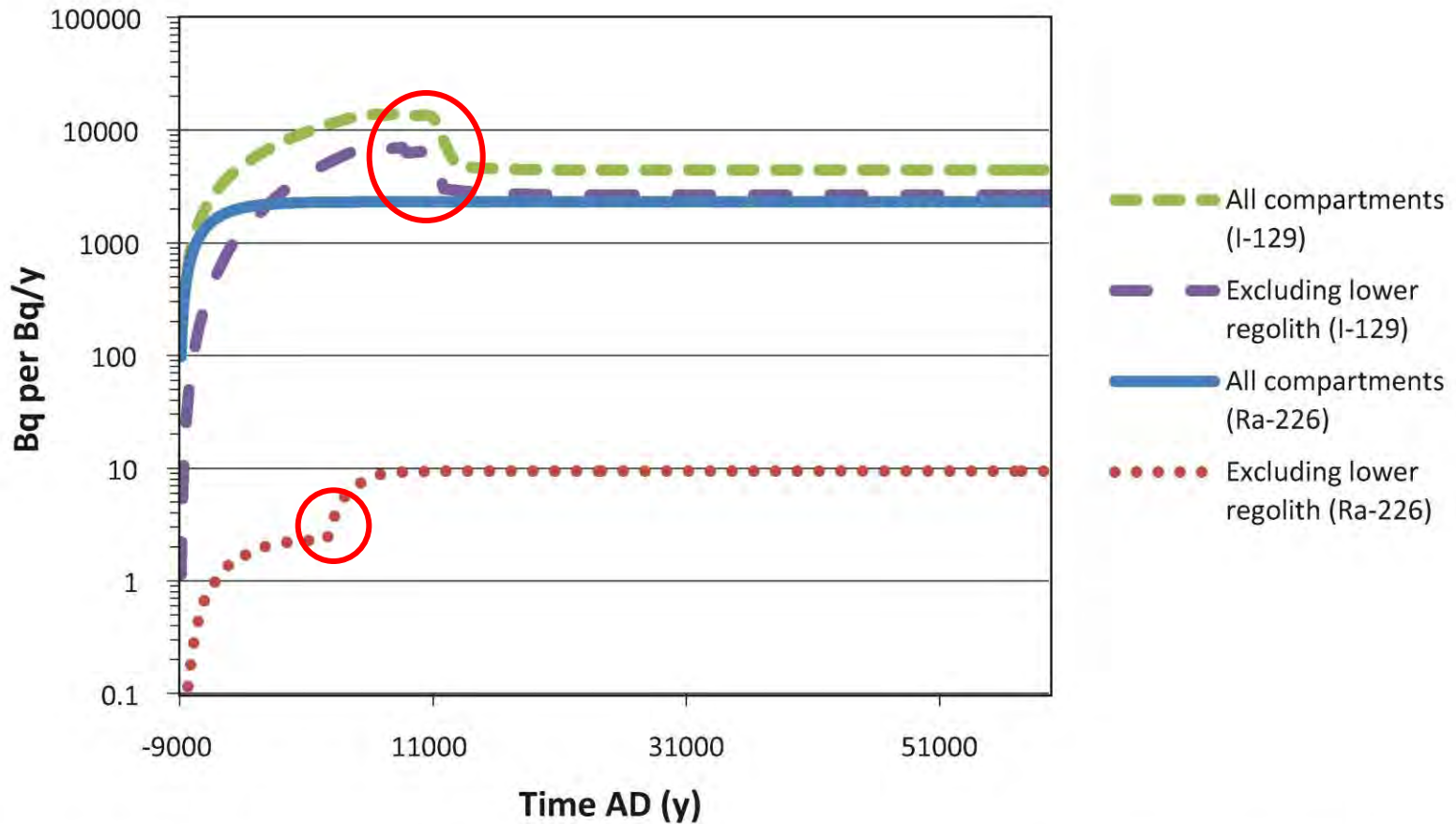


Figure 3-4. Ra-226 and I-129 inventories in all model compartments including and excluding the lower regolith compartment. Maximum values across all biosphere objects are shown. The values were obtained from deterministic simulations with a constant unit release rate during the interglacial period.

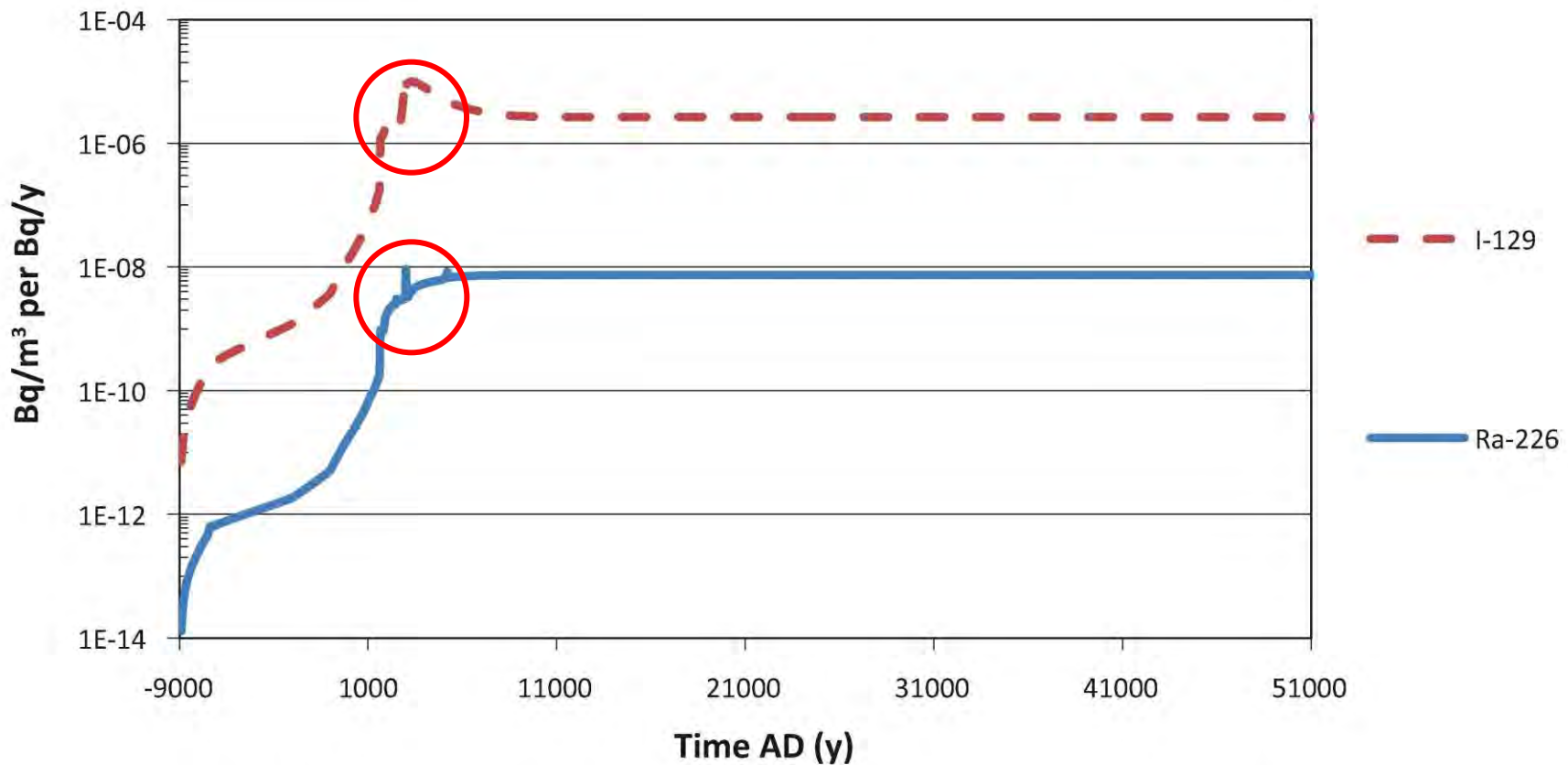


Figure 3-5. Activity concentrations of Ra-226 and I-129 in surface waters. Maximum values across all biosphere objects are shown. The values were obtained from deterministic simulations with a constant unit release rate during the interglacial period.

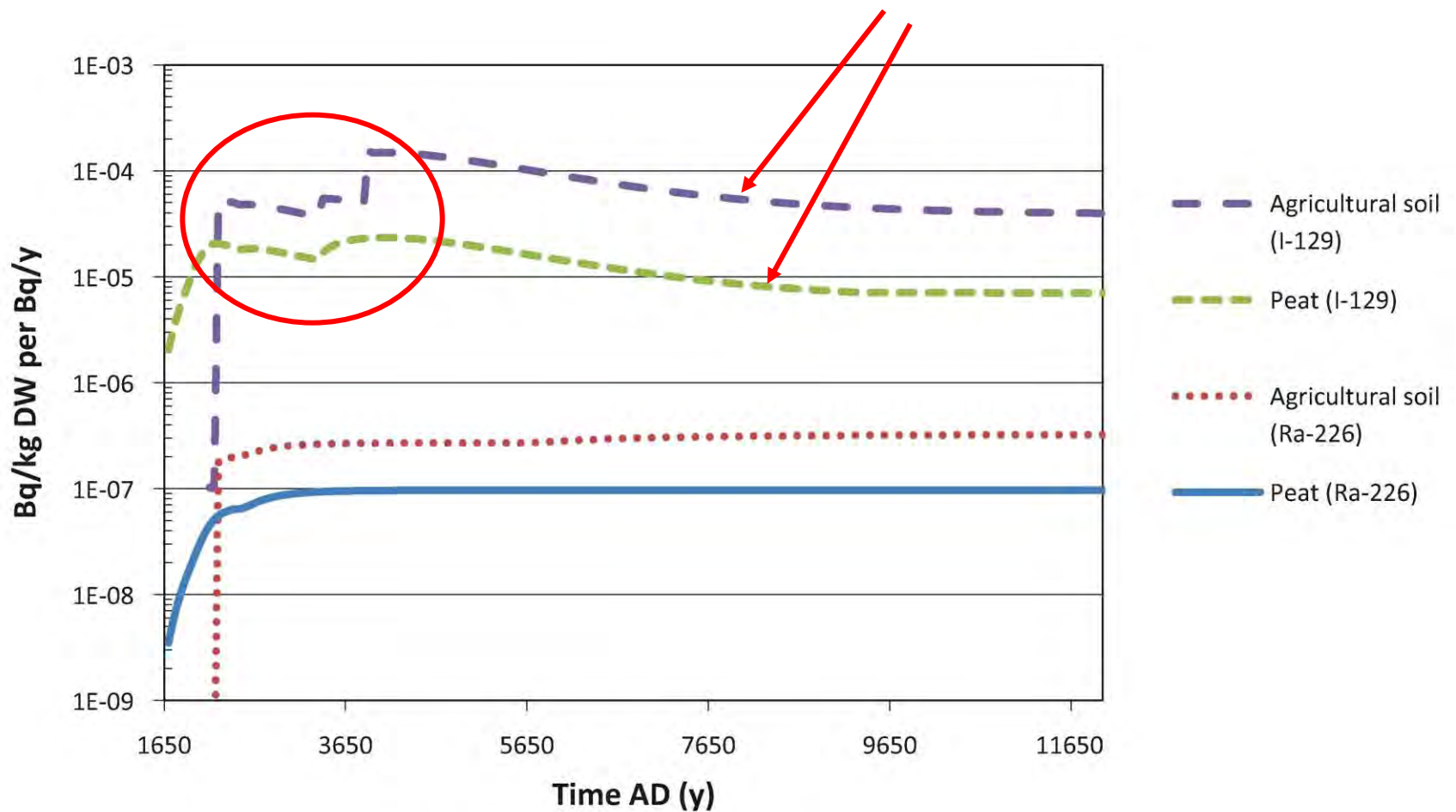


Figure 3-6. Activity concentrations of Ra-226 and I-129 in the upper layer of the mire and in agricultural soil. Maximum values across all biosphere objects are shown. The values were obtained from deterministic simulations with a constant unit release rate during the interglacial period.

* LDF figures difficult to interpret

⇒ dynamics needs explanation

⇒ information on accumulation and (time-dependent) inventories in the individual compartments is missing

⇒ peak values and steep gradients need explanation

* only traditional / low-tech agriculture considered

⇒ for comparison:
today's high-tech agriculture
(greenhouse, irrigation, ...)

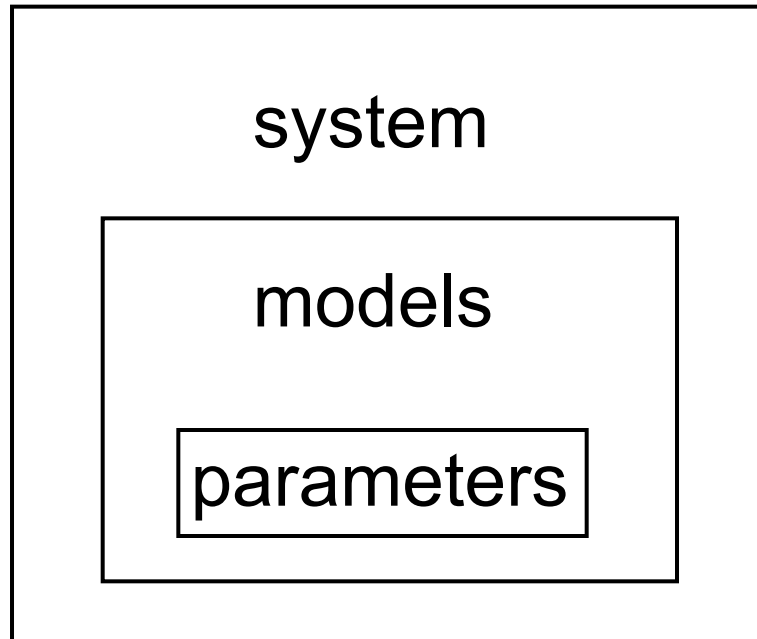
* use of peat as domestic fuel not included
(reference to [SKB, 1999] that insignificant)

⇒ should be checked for nuclides attached to
aerosols in fumes

⇒ also for wood used as fuel

- * more than 140 parameters (biosphere model only)
 - * 50 % well drinking water
- ⇒ difficult to justify

* three hierarchical levels of uncertainties:



++ all levels have been considered

-- not consistent / completely

- * coupling with transport uncertainty analyses ?
- * information is missing on uncertainties of LDF_pulse
- * sensitivity analyses only include effects of **parameter** uncertainties

* limited variation considered for system evaluation

⇒ simulation of global warming limited to extension of its period, other effects are missing (e.g. on erosion, ground water level, irrigation, landscape evolution)

⇒ human impacts (e.g. diking, amelioration of soils, drainage)

⇒ closure of the Baltic Sea basin ?

- * effect of compartment size variations limited to lower regolith
 - ⇒ processes may not be homogeneous within the compartments (e.g. redox-sensitive mobility)
- * long-term irrigation by groundwater is considered unlikely, assumed that by surface water only
 - ⇒ difficult to justify (root irrigation)

* human-related parameters fixed (→ Reference Man)

⇒ difficult to understand

* list of parameters included in MC analyses is missing

⇒ impossible to check whether all major parameter uncertainties considered

* differences in deterministic LDFs and means of MC simulations

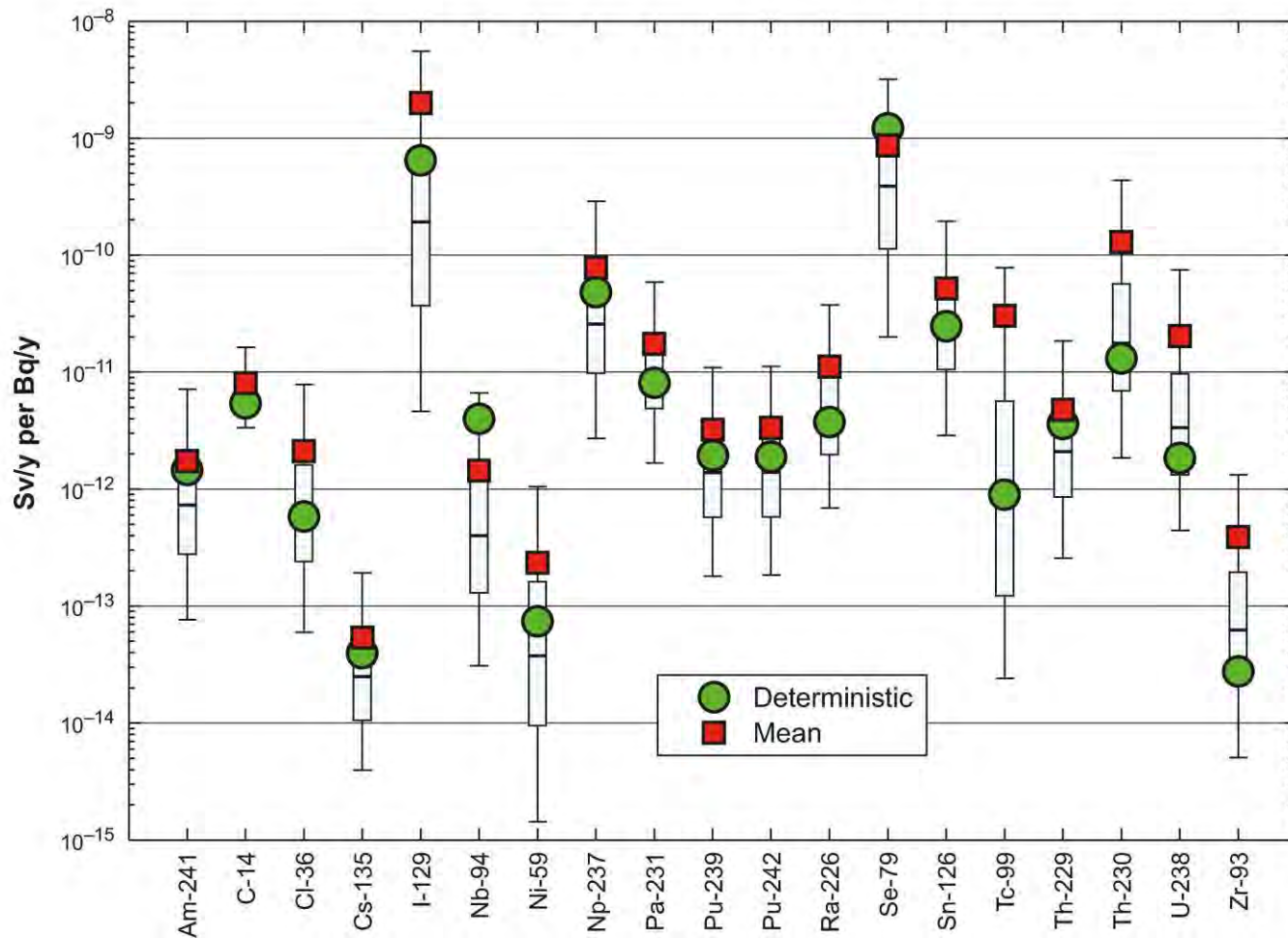


Figure 5-40. Variation in LDF values obtained from probabilistic simulations. This figure shows the distribution of LDF values at the time when the median of the probabilistic output reaches its peak. The mean, median, 5 percentile, 25 percentile, 75 percentile and 95 percentile from the probabilistic simulations are shown. The deterministic LDF value is also shown for comparison.