Chapter 11
Important Phanerozoic Boundaries

A geologic time scale is conventionally considered as equivalent to a biological time scale that is based on evolution of life on the Earth. Using radiogenic isotopes is critical for understanding short-term geologic processes responsible for quick reorganizations of ecosystems at geologically important boundaries. In the Phanerozoic, significant events of mass extinctions occurred in the Early Cambrian, Late Ordovician, Frasnian–Famennian, Permo–Triassic, Late Triassic, Cenomanian–Turonian, and Cretaceous–Tertiary (Erwin 1998). Hereafter we focus on specifications and dating problems of three remarkable transitions: (1) Vendian–Cambrian (V–C), (2) Permo–Triassic (P–T), and (3) Cretaceous–Tertiary (K–T). The available data demonstrate that these boundaries have been caused by different geologic processes and, in fact, cannot be strictly compared to each other.

11.1 Vendian–Cambrian

11.1.1 Stratotype Sections

At the boundary between the Vendian and Cambrian (Precambrian and Cambrian), skeletal fauna appeared in mass quantities simultaneously in various parts of the Earth. The boundary was suggested, primarily, to be placed at the foot of the first biostratigraphic zone of the Tommotian with a complex of the skeletal fossils Aj. Sunnaginicus. The zonal complex is widely distributed in the Siberian platform and adjacent Altai-Sayany fold region. The Tommotian unit of the Siberian platform is mostly mono-facial. It contains no trilobites, but shows records of fossils with phosphate skeleton and Archeocyatha (Raaben 1969). The boundary is defined by $\delta^{13}C$-isotope chemostratigraphy. The Siberian stratigraphers argue that the foot of the Tommotian—the oldest biostratigraphic boundary of a high rank—should be accepted as the global stratotype for tracing the lower boundary of the Cambrian (Khomentovskii and Karlova 2005).

Versions for the global stratotype of the boundary were proposed also between the Vendian and Baltic series on the Russian platform, Yudom (Vendian) and Pestrotsvetnyi (Lower Cambrian) Formations in the Aldan and Lena river basins,
and Nemakit-Daldyn and Sunnaginskii horizons (the foot unit of the Tommotian) in northern regions of the Siberian platform (Sokolov and Fedonkin 1985). As the global stratotype, the sections in Ulakhan-Sulgur (Aldan river, Siberia), Meishuchun (Yunnan, China), and Burin (Newfoundland, Canada) were considered as well (Repina and Rozanov 1992; Landing 1994; Rozanov et al. 1997). The latter section was accepted as the global stratotype by the IUGS.

### 11.1.2 Radiogenic Isotope Ages

Numerous radiogenic isotope ages that aimed for exact definition of the V–C boundary were published by the late 1990s (e.g. Rozanov et al. 1997). Recently, this data set was extended.

Zircons of pebbles from conglomerates, lying near the basis of the Tusera Formation in the Karaulakhskii uplift (Northern Siberia), yielded the weighted $^{207}\text{Pb}/^{206}\text{Pb}$ age of $534.6 \pm 0.4$ Ma (Bowring et al. 1993), which was consistent with the value of the U–Pb zircon age of $530 \pm 5$ Ma at the top package Byanshao in Meishuchun (China) (Sambridge and Compston 1994). Zircons from a tuff layer in a counterpart of the Chapel Formation, Saint-Johns, New Brunswick, Canada, yielded the upper intersection of Concordia at $531 +1.8/−1.1$ Ma and average weighted $^{207}\text{Pb}/^{206}\text{Pb}$ age of $530.7 \pm 0.9$ Ma (Isachsen et al. 1994).

Dates of zircons (SHRIMP) from tuffs of the Mistaken Point Formation, southeastern Newfoundland with the Ediacara fossils, corresponded to three age groups: $607 \pm 1$ Ma, $591 \pm 5$ Ma, and $571 \pm 4$ Ma. The latter was the closest to the tuff age (Compston 1994). Zircons from Slavatyche tuffs, East Poland showed $^{207}\text{Pb}/^{206}\text{Pb}$ age of $551 \pm 4$ (Compston et al. 1992, 1995). Sm–Nd isochron ages of $562.8 \pm 7.9$ Ma, $562.1 \pm 5.7$ Ma, and $570.3 \pm 17.1$ Ma for phosphate bowls and a collophane from the top of the Anabarites-Protoherzina zone, China were not consistent with zircon ages of the top horizons of this zone in the Meishuchun section (Yang et al. 1996).

Carbonates of the second zone of the Tommotian lay above the Tusera Formation in the Kharaulakh uplift with a zircon age of $534.6 \pm 0.4$ Ma (Bowring et al. 1993). This age was considered as the best estimate of the Tommotian foot (Zhamoyda 2000). Carbonaceous rocks from the Upper-Yudom Formation, East Siberia, which underlay the Pestrotsvetniy Formation of the Tommotian, yielded a Pb–Pb isochron of $553 \pm 23$ Ma interpreted as timing of the early diagenesis in sediments (Ovchinnikova et al. 2001).

In Death Valley, USA the Cambrian biota occurs in the Canyon Wood Formation, and the Vendian one in the underlying Stelling quartzites. Samples from the latter unit show positive excursion of $\delta^{13}\text{C}$ from $−0.9‰$ to $+1.6‰$ (relative to PDB). The positive values of $\delta^{13}\text{C}$ in carbonates with the Ediacara forms, found above a contact between the Stelling quartzites and Canyon Wood, are correlated with those in sediments of Namibia (Grotzinger et al. 1995; Saylor et al. 1998) and Canada (Narbonne et al. 1994). The sharp negative excursion of carbon isotopes up to $−4‰$ was found at the foot of the Canyon Wood Formation. Stratigraphic correlations and radiogenic isotope