Chapter 2
Thermal History of Sedimentary Basins
Temperature is the most important single parameter to be studied. It is the driving force for petroleum generation and many other chemical and transport processes. Basin modeling provides a unique opportunity to investigate temperature regimes in space and time. A prerequisite of meaningful temperature reconstruction are adequate temperature sensitive calibration data, such as those derived from organic geochemical maturation parameters, fluid inclusions, fission tracks, or illite crystallinity. This calibration of thermal histories is discussed in this chapter.

The wholistic approach of basin modeling allows analysis of the timing and sequence of events in great detail. Thereby the reconstruction of temperature history and the application of a modified form of chemical reaction kinetics play the decisive role. The thermal history of a basin can be described as a time-dependent energy balance which is controlled, on the one hand, by heat entering and leaving the basin and, on the other, by the ability of the sedimentary fill in the basin to transmit and store heat.

Accordingly, the physical and mathematical aspects of heat transfer and storage under the changing ambient conditions of a basin are treated. The thermophysical material parameters of the sedimentary rocks filling the basin and related changes induced during the evolution of a basin are discussed along with the input of thermal energy at the basin floor and heat losses at the surface. The above changes of the ambient conditions in the subsurface are largely controlled by four geological processes, i.e., by deposition of sediments, periods of nondeposition, processes related to the deformation of the basin fill, and erosion of sediments. These processes are identical with the main processes which must be accounted for when constructing the conceptual geological model for the basin simulation procedure as described in Chapter 1.

For the reconstruction of thermal histories via numerical simulation the conceptual model can provide the only geological framework; the points of reference (calibration), must be derived from organic or inorganic temperature sensitive parameters.

The thermal history of a given rock unit at any one point in the basin is determined by the combined effects of all the variables influencing heat transfer and storage. However, as with many complex interrelationships of this nature, sensitivity studies and/or case histories can single out dominant geological effects which have a decisive influence on temperature histories. Therefore this chapter includes case histories explaining the effect of very low sea bottom temperatures upon the heat budget of underlying rock strata, showing the influence of magmatism, the role of salt as an excellent thermal conductor, and the interplay of subsidence and uplifting upon an individual temperature history curve.