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The nonlinear inversion of paleogeothermal evolution: example from the north part of South China Sea

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The paleogeothermal history of the north part of South China Sea is studied with the nonlinear inversion method and the detailed structural and thermal evolution models. The thermal model implies the variation of basal heating flow with time, thermal conductivity with sediment porosity and composition. The heating flow does the variation with the geohistory as the nonlinear function of time. But for the effective calculation, the linear function of heating flow as age in a small piece of time has been considered as follows:

$$Q_n = Q_{n-1}(1 + b_n(t_n - t_q))$$

Q_n is the heating flow in time t_n; t_q is the time of tectonic changing violently; b_n is the slope of Q_n against time t_n.

Based on the minimum square technique, I make the objective function as follows:

$$\Phi(b_1, b_2, \ldots\ldots b_n) = \sum_{i=1}^{N} (\bar{R}_0(z_i) - R_0(z_i))^2$$

$\bar{R}_0(z_i)$ is the measured vitrinity reflectance at z_i while $R_0(z_i)$ is the modelled one at z_i and it is the function of TTI and can be computed using Loptin Method or Arrhenus Equation. From objective function and heating flow model, the nonlinear inversion of heating flow can be getting on.

The application in the nonlinear inversion model is illustrated for the north part of South China Sea. The temperature measurements, thermal conductivity, heating flow, stratigraphic and areal and well geophysical data in the area were collected and processed to built framework of models of burial, structural and thermal histories. The results show the area has undertaken at least three extensions since the Later Mesozoic period, as the heating flow has different features in different periods. Also the variation of temperature and thermal maturation of source rocks have been evaluated and the results show almost pre-Cenozoic source rocks give over-matural features and Earlier Tertiary source rocks in some areas also do. The Eocene, Oligocene and Miocene source rocks are now entering the "Oil Window" environments.

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