

Statistical Techniques for Constructing Geological Time Scales

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Geological time scales are constructed by combining stratigraphic information with radiometric dates and their standard deviations. The stratigraphic record consulted includes litho-, bio-, chrono-, cyclo-, and magnetostratigraphy. The statistical methods should embody concepts and data available for the systems considered. As in the past, ages of stage boundaries can be estimated by application of the chronogram method, or maximum likelihood, to a worldwide database of chronostratigraphically classified dates. This method, which also can be applied to more closely spaced zone boundaries, results in age estimates accompanied by standard deviations. For the Tertiary, Cretaceous and upper half of the Jurassic, magnetostratigraphy and seafloor spreading models play an important role. For the Mesozoic, supplementary information is provided by incorporating the hypothesis of equal duration of ammonites subzones. A final time scale can be obtained by calibration using cubic smoothing splines or other graphical and curve-fitting methods.

New challenges for constructing the new 2001 numerical time scale include (a) use of new age determinations including $^{40}\text{Ar}/^{39}\text{Ar}$ dates which rapidly are becoming available and can be an order of magnitude more precise than earlier dates, and (b) astronomical calibration of the time scale by cycle-tuning. For each method a careful distinction should be made between accuracy and precision. Accuracy is improved by recalibration, using improved decay constants or new information on Milankovitch cycle periodicities.