Thesis Abstract

Thesis title : Statistical analysis of thermoluminescence experiments for sedimentary dating.
Author : W.Chandanie Wijayalatha Perera
date : July 1996
degree : Doctor of philosophy - Simon Fraser University
speciality : Mathematics and Statistics.

Abstract:
Sediment (or other buried material) when heated gently glows with light called thermoluminescence. The amount of light given off depends on the material and on the amount of the radiation impinging on the sample while buried. Comparison of the equivalent dose (a known laboratory dose required to produce the same amount of luminescence as the original untreated sample) with historical radiation rates permits estimation of the age (duration of burial) of the sample, a process called thermoluminescence dating.

We study statistical techniques for estimating the equivalent dose from the data collected for thermoluminescence dating. Physical models are used to motivate generalized non-linear models for the data and to justify assumptions about the distribution of errors in these models. Maximun likelihood, quasi-likelihood and least squares estimators are compared by examining their statistical propreties. Formulae are provided for the biases and the mean squared errors of these estimators valid in the limit of small measurement errors.

In thermoluminescence studies, data are collected on a single sample at a series of temperatures. Consequently, observations collected at different temperatures are correlated. We propose a generalized estimating equations procedure for estimating the equivalent dose from the correlated data. Large sample asymptotic properties of the proposed estimate are examined and a formula is provided for estimating the error of the estimate. We propose symmetric confidence intervals for the equivalent dose with a *t* quantile; a formula is provided for the approximate degrees of freedom of the suggested *t* quantile, valid in the limit of small measurement errors. Finite sample performance of the asymptotic results is examined by Monte Carlo.

Test based on the empirical distribution function (EDF tests) of the standardized residuals are proposed for testing the distributional assumptions on the random errors in two situations : without assuming the fitted model is correct and assuming the fitted model is correct. We propose a recurrence formula for evaluating the cumulative distribution function of two fitted standardized residuals needed in the proposed EDF tests. Weak convergence properties of the related empirical processes are examined. Finite sample performance of the suggested EDF tests is examined by Monte Carlo.