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Red Boles in the Deccan traps: Time constraints from alteration processes.

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Huge continental flood basalts (traps) result from the stacking of numerous lava flows, many of which reach well in excess of 50 meters thickness. The total volume of a trap often exceeds one million km^3. Several of these uncommon geological objects appear to be synchronous with major mass extinctions during the Phanerozoic. The Deccan traps in India erupted 65 Ma ago and it is argued that they are in some way related to the Cretaceous-Tertiary (KT) mass extinction. Trap emplacement is not a continuous process. Some time intervals of volcanic quiescence are recorded as numerous inter-trappean layers (including the so-called “red boles”, or RB), which are generally less than one meter thick. These red boles mainly occur in the upper part of the traps, in the Ambenali and Mahabaleshwar Formations. They bear witness to the processes occurring between emplacement of two successive lava flows. Red boles generally occur with a sharp transition, below the upper lava flow. Stratigraphic profiles of several red boles were sampled along the Mahabaleshwar-Poladpur road and a parallel traverse, the Wai road section. The less developed RBs, a few centimeters thick, are made of red silty clay and occur within fractures in the upper blocks of the lower lava flow. When more evolved, a RB is characterized by a red compact silty clay with relics of feldspars and voids, occurring over a few tens of centimeters, grading to an orange silty clay with friable vesicular relics of blocks of basalts, over about one meter,

overlying brown clay jointed lava flow. Less than one meter of massive altered lava flow underlies the red bole. Mineralogical data indicate a paragenesis dominated by smectites, zeolites and hematite. Micromorphological observations revealed voids or fissures coated by smectites, growing botryoidally, and infillings of zeolites all over the profile. In the red clayey horizons or jointed lava flows, alteromorphs after feldspar occur. In the underlying altered massive lava flow, fresh primary minerals occuring in a smectitic matrix are observed. Based on the micromorphological and mineralogical data, a dominant hydrothermal alteration process is proposed for red bole formation. We propose that the duration of formation of red boles was quite short, much shorter than generally assumed. From a comparison with formation of paleosols developed on volcanic deposits under various climatic conditions, we propose that many of the red boles we observed in the top part of the Deccan lava pile were formed in less than 1000 years. In order to further constrain the duration of volcanic quiescent intervals, this study was conducted in parallel with a detailed magnetostratigraphic study. During cooling, lava flows record quasi-instantaneously the direction of the Earth's magnetic field. Secular variation of the geomagnetic field can then be used as a relative time proxy, which allows an estimate of the time needed to generate a red bole. This is the subject of a companion abstract (Chenet et al). For instance, because a red bole is sandwiched between two flows which have recorded the same transitional direction between chrons C29R and C29N, the duration of formation of that particular red bole cannot be longer than a few decades. Joint use of paleomagnetic and mineralogical constraints allows us to estimate the duration of red bole formation in a number of cases and helps in constraining the total amount of time recorded in the Deccan pile.