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Aerial volcanism and cold intervals during the Cretaceous : a causal link ?

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Plinian or ultraplinian eruptions are followed by a climatic cooling which duration depends on the nature, quantity, and residence time of stratospheric aerosols that intercept solar irradiance. The intensity of explosive eruptions is estimated using the Volcanic Explosivity Index (VEI). A Pinatubo-size volcanic eruption (VEI = 6) occurs on the average of once a decade, a Tambora-size eruption (VEI = 7) once a century, and a Toba-size eruption (VEI = 8) every 100 000 years. At a secular time-scale, closely-spaced volcanic eruptions may have produced cold intervals such as the Little Ice Age (Briffa et al., 1998). Volcanic triggering of late Pliocene glaciation is also suggested by the record, in the North Pacific Ocean, of increasing flux of volcanic glass followed by ice-rafted material (Prueher & Rea, 2001). Therefore, the possible influence of aerial volcanism on cool climatic intervals occurring in the Cretaceous should be addressed.

Bentonites are the best markers of huge volcanic eruptions. These centimetre-thick clayey horizons are generally composed of dominant smectites derived from the submarine weathering of volcanic glass shards. In Cretaceous marine formations from Northwest Europe, bentonites occur mainly in Valanginian, Lower Aptian and Mid-Upper Turonian, and occasionally in the Cenomanian. In the Valanginian, active volcanic centres were probably located along the northern margin of the Tethys and associated with a subduction zone, while from the Aptian to the Turonian, active volcanism is associated to the opening of the North Atlantic Ocean. In the Valanginian, the duration between two successive bentonite layers is estimated between 80 000 years and 1 Ma, while in the Mid-Upper Turonian, the average frequency of huge volcanic events is around 200 000 to 400 000 years. This suggests that only ash-falls of Toba-size eruptions are preserved in the sedimentary record, but frequent minor eruptions should have occurred between these paroxysmal eruptions.

Oxygen isotope ratios measured either on selacian tooth enamel or on carbonates of Cretaceous age, indicate that episodes of lower seawater temperature are recorded during the Valanginian, the Aptian and the Turonian (Pucéat et al., 2003), that is, during intervals characterised by an increased occurrence of bentonites. A similar coincidence also occurs in the Jurassic (Lower-middle Oxfordian), where bentonites are frequent and a cool episode has been inferred from the abrupt transition from carbonate platforms to terrigenous clay sedimentation and from an increase of oxygen isotope ratios of selacian teeth (Lécuyer et al., 2003). The overall correspondence between increasing explosive volcanic activity and cool intervals suggests a causal link. Volcanic eruptions can influence climate through two processes: 1) an increase of volcanic aerosols in the atmosphere can induce a cooling and 2) ash-falls can result in fertilisation of the surface waters, increased productivity and uptake of CO_2 by photosynthetic organisms (Frogner et al., 2001). Although other perturbations of the carbon cycle (like changes in organic matter preservation) are likely to have played a major role in the cool climatic intervals of the Cretaceous, the influence of aerial volcanism should be also considered, notably as a mechanism that may have enhanced a climatic deterioration.

Briffa K.R., Jones P.D., Schweingruber F.H., & Osborn T.J., 1998. Influence of volcanic eruptions on Northern hemisphere summer temperature over the past, 600 years. Nature, 393, p. 450-455.

Frogner P., Gislason S.R. & Oskarsson N. 2001. Fertilizing potential of volcanic ash in ocean surface water. Geology, 29, 6, 487-490.

Lécuyer C., Picard S., Garcia J.P., Sheppard S.M.F., Grandjean P. & Dromart G. 2003. Thermal evolution of Tethyan surface waters during the Middle-Late Jurassic: Evidence from $\delta^{18}O$ values of marine fish teeth. Paleoceanography, 18/3, 1076.

Prueher L.M., & Rea D.K. 2001.- Volcanic triggering of late pliocene glaciation: evidence from the flux of volcanic glass and ice-rafted debris to the North Pacific ocean. Palaeogeography, -climatology, -ecology, 173, 215-230.

Pucéat E., Lécuyer C., Sheppard S.M.F., Dromart G., Reboulet S., & Grandjean P. 2003. Thermal evolution of Cretaceous Tethyan marine waters inferred from oxygen isotope composition of fish tooth enamels. Paleoceanography, 18/2, 1029.