NON-EVIDENCE OF LIGHTNING AND ASSOCIATED VOLCANISM AT VENUS

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Abstract. Reports of unpredicted 'lightning' and its spatial association with mountains of possible volcanic origin are provocative features of the 1980's literature on Venus. These reports are based upon interpretation of low-frequency 100 Hz electric field noise observed from the Pioneer Venus Orbiter during 1978–1986. These speculations have been repeatedly challenged in the literature. Even though explosive volcanism, like lightning, is discounted in the literature, researchers have been prompted to believe in present-day eruptions by the suggestion that volcanic plumes might stimulate the otherwise unexpected lightning. Recent introductions of a distinct set of higher-frequency electric field noise has resulted in further claims for lightning, but these results, like those derived from the 100 Hz data are discounted by several independent studies. Commenting on the large body of 100 Hz data, Russell (1991) abandons earlier reports of the planetographic clustering of this noise, and states that active volcanoes are not the source of the Venus 'lightning'. This welcome acknowledgement leaves unresolved problems. First, this brief comment is quite insufficient to correct the widespread and flawed perception that Venus is currently experiencing widespread lightning, stimulated by volcanic disturbances. Second, this admission leaves unexplained the origin of the voluminous 100 Hz data set. The foregoing problems, combined with negative results of recent independent studies, indicate strongly that the Pioneer Venus results provide no reliable evidence of either lightning or volcanism at Venus.

1. Perception of Coupled Lightning and Volcanism

In an example of layered speculations, reports of lightning, linked to regions of suspected explosive volcanism, emerged during the 1980's as among the most potentially significant of the Venus characteristics deduced from observations by the Pioneer Venus Orbiter (PVO). The vast majority of measurements prompting this scenario are recordings of electric field noise. A very extensive data set of low-frequency noise, appearing exclusively at 100 Hz, was compiled from many hundreds of orbits spanning more than nine Venus years. This noise was attributed to widespread lightning across the nightside, in papers beginning with Scarf et al. (1980) and extending to Russell (1991). Through the decade, those reporting the lightning interpretation further asserted that the noise clustered significantly over mountainous regions including Atla and Phoebe Regios, and Aphrodite Terra (Scarf and Russell, 1983, 1988).

Temptation for associating the noise with mountains of possible volcanic origin arose from the fact that naturally occurring lightning was dismissed, due to prohibitive atmospheric conditions at Venus. For example, Esposito et al. (1983) state: "There is little evidence of potential latent instability in these (Venus) clouds, nor for the existence

of large precipitation particles. Known processes for the formation of lightning require both.” In the same context, Levin et al. (1983) argued that the high atmospheric pressure and the dielectric properties mitigate against charging necessary for natural lightning formation.

Thus, if the noise were found to be spatially linked to mountainous regions of volcanic origin, one might speculate, in turn, that explosive volcanic eruptions providing particles and dynamics, might produce the missing conditions for lightning formation. This weak scenario was evidently adopted by those reporting the notion of widespread and almost incessant lightning over large regions of the nightside of the planet.

The dramatic topographic clustering of the 100 Hz noise reported by Scarf and Russell (1983) predictably stimulated a succession of speculations on the possibility of currently active volcanism. Specifically, Esposito et al. (1983), after dismissing the possibility of natural lightning went on to state; ‘it appears that it (the 100 Hz noise attributed to lightning) is strongly correlated with geographic locations’, and later ‘This suggests that lightning might be associated solely with volcanic activity.’ Similarly influenced, Ksanfomaliti (1985) stated: ‘So, even though we still lack direct proof that Venus is experiencing volcano, there would seem to be no other way of explaining why the electromagnetic pulses recorded by the PVO were so highly concentrated (over mountainous terrain).’ In the same year, Burgess (1985) stated: ‘most of the signals assumed generated by lightning discharges originate at Beta Regio and Aphrodite Terra, which should suggest the presence of volcanic plumes’, and ‘Because there is little overturning of the lower atmosphere of Venus, and no precipitation or thundercloud type activity, it seems most likely that the lightning discharges are produced in volcanic clouds over active volcanoes.’ As we will show in Section 3, this flawed perception of lightning providing evidence of current volcanism persists even to this time, and has encouraged fruitless searches for evidence of these conditions.

2. Rejections of the 100 Hz Noise Interpretation

The asserted evidence for lightning as the source of the extensive amount of 100 Hz noise has been challenged repeatedly. Papers by Taylor and Cloutier (1986) and by Taylor et al. (1987) provided evidence that the noise is associated with ionospheric disturbances occurring in the vicinity of the PVO, and thus unrelated to the lower atmosphere. These studies documented a unique correlation between the 100 Hz noise and ion discontinuities, or troughs, resulting from the solar wind interaction with the nightside ionosphere.

The significance of the noise-through correlation was recognized by Scarf (1986) who stated that if the correlation was shown to persist, the lightning interpretation would have to be withdrawn. Although Taylor and Cloutier documented this very persistence, the flawed interpretation has not been withdrawn.

Taylor and colleagues also showed conclusively that the 100 Hz noise appeared randomly across the nightside, as do the ion throughs, and thus documented that the reported planetographic clustering was, in fact, non-existent. Given this evidence,