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Communication

Earth Tides and H_2 Venting in the Sao Francisco Basin, Brazil

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Abstract: Hydrogen gas seeping from Proterozoic basins worldwide is a potential non-carbon energy resource, and the vents are consequently receiving research attention. A curious feature of H_2 venting in the Sao Francisco Basin in Brazil is that the venting displays a very regular daily cycle. It has been shown that atmospheric pressure tides could explain this cycle, but solid earth tides might be an alternative explanation. We show here that it is unlikely that solid earth tides are a dominant control because they have two equally strong peaks per day whereas the H_2 venting has only one.

Keywords: diurnal hydrogen gas venting; earth tides

1. Introduction

The quest to reduce dependence of fossil fuels has raised interest in hydrogen as a carbon-free fuel that combusts only to water. Hydrogen seeps are known in a number of Proterozoic basins worldwide [1–5]. Satellite detection of roughly circular depressions with depressed vegetation has become an exploration method, since the H_2 seeps are often associated with these features [3,5]. One H_2 vent in the Sao Francisco Basin in Brazil has been the subject of detailed monitoring since 2018. It shows a remarkably regular diurnal cycle of hydrogen venting wherein H_2 is vented for only about half the day centered on 1:00 p.m. [3]. A recent paper shows that the atmospheric pressure tide at the site could explain this venting [4]. The association with a ~550 m diameter circular depression aligned linearly with others in the area presumably along a fault suggests the venting could be from a deeply penetrating gas pipe. Earth tides are known to induce water flow in and out of wells [6–8]. The purpose of this paper is to evaluate the possibility that earth tides cause the diurnal gas venting at the Sao Francisco vent site studied by Cathles, Prinzhofer, and Donzé et al. [4,5]. Following Donzé et al. [5] we will refer to this site as the H2G site.

2. Methods

To evaluate the possibility that the diurnal venting at the H2G site could be caused by solid earth tides, we computed the solid earth strain at the location studied in Cathles and Prinzhofer [4] using the theoretical tidal loading software SPOTL [9] and compared it to the variations in H_2 concentration at 80 cm depth for sensor 6 in Figure 1b below. The theoretical earth tide strains determined with this software have often been used in the analysis of high-resolution borehole water level time-series measurements, since the tidal amplitude response and phase shift within a well or borehole are controlled by the formation permeability and specific storage [7,8].

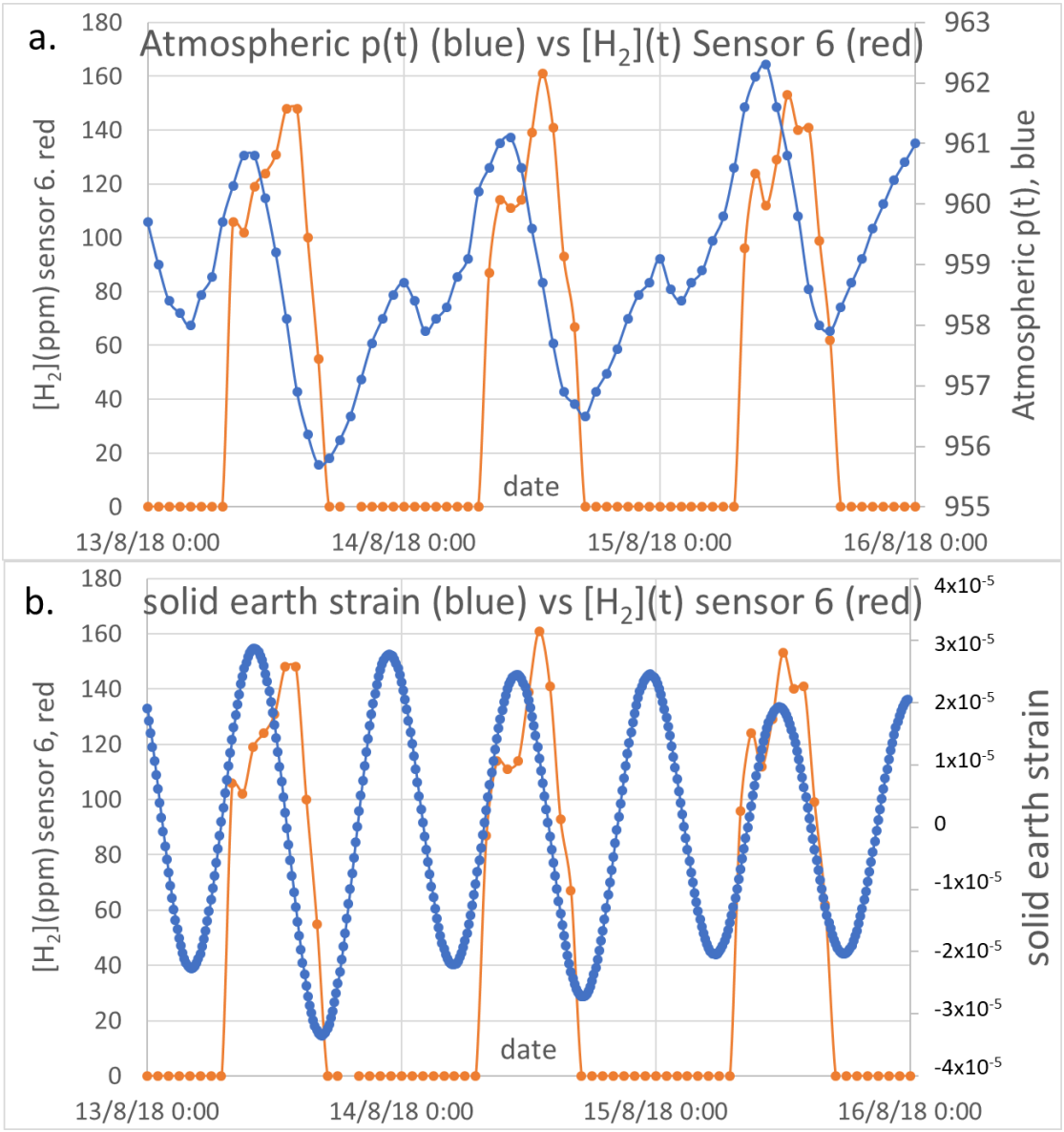

Figure 1. (**a**) Comparison of changes in atmospheric pressure to observe changes in H_2 concentration at 80 cm depth at the location studied by Cathles and Prinzhofer [4] from the 13th to the 16th of August 2018. (**b**) Comparison of changes in solid earth tidal strain at the same site over the same period.

3. Results

As can be seen from Figure 1a and as noted by Cathles and Prinzhofer [4], the changes in H_2 concentration are closely aligned with the maximum rate of decrease in daily atmospheric pressure (the atmospheric tide). Unlike the atmospheric tide, which has one dominant cycle per day, the solid earth tidal strain has two cycles per day (Figure 1b). Although one of the cycles could assist the H_2 venting, no changes in H_2 concentration are associated with the second which is equally strong.

4. Discussion and Conclusions

Because the solid earth tide has two equally strong peaks each day at the H2G site whereas the H_2 venting peaks only one, it appears unlikely that solid earth tides play a dominant role in producing the observed daily changes in H_2 venting in the Sao Francisco Basin of Brazil. It is possible that the solid earth tide contributes to the venting, but the atmospheric pressure tide must be (and could be) the

dominant control. Biologic control on venting is, to our knowledge, the only other potential control. It awaits evaluation.

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