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Interactive comment on "Geophysical and geochemical signatures of Gulf of Mexico seafloor brines" *by* S. B. Joye et al.

S. B. Joye et al.

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Referee #1 (R. Carney) Response to scientific points raised by the referee We thank the reviewer for his thorough and insightful comments on our paper. The reviewer was correct in stating that our discussion of brine sources was rather conservative. We have broadened the discussion of our paper regarding the source of seafloor brines and the geobiological repercussions of different brine sources and/or dilution regimes.

The reviewer presented several questions about the thermal stratification and chemical distribution data for the two brine pools. First, the reviewer noted that the temperature profiles shown in the present paper for the GB425 brine differ from those presented in MacDonald et al. 2000. We regret that when modifying the figure, the deeper portion of the 1998 profile was cropped off and that depth profile inadvertently shifted. We have corrected this error in the revised manuscript and the figure is now the same as that presented by MacDonald et al. 2000.

The reviewer questioned the temporal collection sequence of CTD and brine trapper data and asked whether the two data sets reflect an apparent discrepancy in mixing regimes in the brine pool. The temporal sequence of sampling was noted in Section 2.2 in our manuscript but we have further clarified this in the revised manuscript. The CTD data and the majority of the brine trapper geochemical data (with the exception of the 1998 methane data shown in Table 1) were not collected contemporaneously; thus, the temperature profiles shown in Fig. 6 do not correspond temporally with the geochemical profiles shown in Figs. 7 & 8. From the data shown in Fig. 6, we know that the thermal structure of the pools varies substantially over time, particularly at GB425.

The CTD profiles were collected by hovering the submersible over the middle of the pool and lowering the CTD into the pool. Typically, CTD profiles contained a meter or more of profile through the overlying water (though only a 0.5 meter section is shown in Fig. 6A). When positioning the brine trapper, our goal was to capture the seawater-brine interface (as noted visually by a density discontinuity, which is apparent as light refracts across the interface) and to be as close to the pool surface as possible (as gauged by location of the rim of mussels at GC233 and the sediment around the pool at GB425). When sampling with the brine trapper, the submersible hovered about three meters above the pool and then the brine trapper was positioned vertically and lowered into the pool slowly (so that we didn't hit bottom) until the upper chamber was just slightly above the interface. The brine trapper was then equilibrated and closed. We could not use the brine trapper in areas of vigorous, intense bubbling because it was impossible to pinpoint the sediment water interface and we could not see the trapper clearly, thus raising the possibility of hitting bottom and damaging the instrument. The sampling strategy for CTD and brine trapper collections thus differed slightly.

The three temperature profiles shown for the brine pool site (Fig. 6A) appear to suggest one flow regime in 1992 and 1998, when steep gradients between the overlying seawater and the underlying brine were noted, and a different flow regime in 1991, when a more gradual gradient between the overlying seawater and the underlying brine was

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observed. Unfortunately, we do not have major ion data to accompany the temperature data shown in Fig. 6; nor do we have temperature data to accompany the geochemical data shown in Figs. 7 & 8. We believe, however, that there is no reason to question the validity of geochemical profiles present in the brine trapper samples (Fig. 7 & 8) and we believe the thermal and geochemical data are mutually supportive, not contrary to one another. It is possible that, at the brine pool, the brine trapper sampled the second (654.5m) thermocline that is apparent on Fig. 6A. A thermal profile similar to that observed in 1991 (between 654.5 and 656.5 m) would likely generate a broad geochemical mixing zone, similar to that we observed.

We agree that the pools could serve as particle traps and have amended the discussion to reflect the potential influence this could have on silicate and ammonium dynamics. However, it is also likely that as (hot) deeply sourced brines flow through sediments, silicate and ammonium are enriched in the fluid. Both of these points are elaborated on in the revised discussion.

Finally, the reviewer challenged our conclusion that the GB425 mud volcano supports more active fluid flow than the GC233 site. We stand by this conclusion and have added text to strengthen it.

Response to the technical corrections suggested by the referee 1. The methods section includes techniques for determination of DIC, and DIC results are discussed. The DIC data should be included. The DIC data were included in the paper (Figure 10, bottom Y axis).

2. Methods for determination of percent suspended solids need to be added. The suspended solids method has been included (see section 2.3).

3. P. 648 line 22 - fluid discharge should read gas discharge The wording has been changed, as suggested.

Referee #2 (anonymous referee) Response to scientific points raised by the referee We

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thank the reviewer for providing thoughtful comments on our paper. We have broadened the discussion of our paper to include discussion of brine discharge, discharge frequency, and migration and mixing of deeply-sourced brines with seawater. Microbial activity certainly plays a significant role in mediating the geochemical signature of the brines (this topic is covered in another paper that is being prepared for submission). To date, we have not been able to determine the absolute depth of either pool, but it is likely that the pools are at least 5m deep, if not deeper.

Interactive comment on Biogeosciences Discussions, 2, 637, 2005.