UNRAVELING VENUS' GEOLOGICAL PAST: LINKING MELT COMPOSITIONS TO RESERVOIR AND DEPTH. J. Semprich[1], [1]AstrobiologyOU, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK (julia.semprich@open.ac.uk).

Introduction: Surface measurements [e.g., 1] and terrestrial crystallization experiments [2] are indicative of magmatic diversity of venusian basalts due to variations in melting depth and volatile content. Linking surface compositions to melting depth and reservoir is therefore crucial to further constrain Venus' tectonic regime and geological evolution and will contribute to the interpretation of orbital spectral data obtained by upcoming Venus missions [e.g., 3]. Here, I use petrological modeling to determine the compositions of partial melts formed from basalt and peridotite on several thermal gradients, compare them to Venera analyses, and predict potential formation scenarios.

Methods: Phase equilibria and partial melting were modeled using the Gibbs free energy minimization software Perple_X [4] and an internally consistent thermodynamic dataset [5]. Starting compositions were a terrestrial peridotite [6] and a basalt based on Venera 14 data [e.g., 2]. The system was assumed to be dry and Fe_2O_3 was set to 0.3 wt % for the peridotite and to 10 % of total iron for the basalt. I used solid solution models for olivine, orthopyroxene, clinopyroxene, garnet, spinel, melt [7], plagioclase [8, 9] and ilmenite [10]. Melt compositions were extracted at >10 vol % and the melt was not fractionated.

Results: The composition of the modeled melt depends strongly on the thermal gradient and melt fraction for peridotite and basaltic protoliths as shown by SiO_2 and FeO contents of the melts in Fig. 1. Deep mantle melts on a relatively low thermal gradient of 10 °C/km (dark green circles) are the most depleted in SiO_2 (~44-46 wt %) and can contain higher FeO (>11 wt %) than mantle melts on other thermal gradients (lighter green circles). These signatures are consistent with Venera 13 analysis although mantle melting at higher thermal gradients (15-25 °C/km) could also result in similar melt compositions within the relatively large uncertainties of surface analyses. Partial mantle melts on higher thermal gradients (20-25 °C/km) can contain higher SiO_2 (~45-51 wt %) and slightly lower FeO and are comparable to Venera 14. Partial melts of the basaltic protolith (blue diamond) also match Venera 14 compositions.

Discussion: Venera 13 was interpreted to be an alkali basalt which may have formed by deep partial melting of a carbonated source region [2]. My results agree with a deep mantle source, which could indicate a low thermal gradient and therefore a stagnant lid regime. Venera 14 has been identified as tholeiite suggesting relative shallow mantle melting [2], which matches modeling results for higher thermal gradients and a mobile lid. However, partial melts of mafic crustal rocks could also result in a similar composition, which would indicate crustal recycling by delamination. Future models will have to include volatiles and melt fractionation to determine how these variables influence surface compositions.

References: [1] Surkov Y. A et.al. (1984), *JGR, 89*, B393-B402. [2] Filiberto, J. (2014), *Icarus, 231*, 131-136. [3] Helbert, J et al. (2021), *Sci. Adv. 7*, eaba9428. [4] Connolly J.A.D. (2005), *EPSL, 236*, 524-541. [5] Holland T.J.B. and Powell R. (2011), *JMG*, 29, 333-383. [6] Davis F.A. et al. (2009), *Am Min, 94*, 176-180. [7] Holland T.J.B. et al. (2018), *J Pet, 59*, 881-900. [8] Holland T.J.B and Powell R. (2003), *CMP, 145*, 492-501. [9] Jennings E.S. and Holland T.J.B. (2015), *J Pet, 56*, 869-892. [10] White R.W. et al. (2000), *JMG*, 18, 497-511.

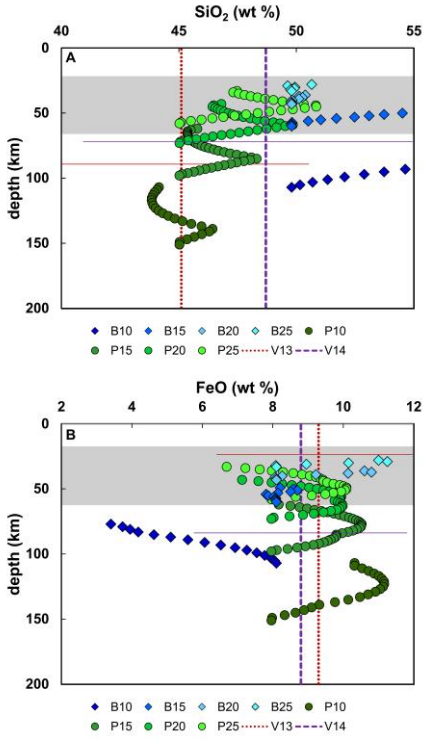

Figure 1: SiO_2 (A) and FeO (B) in wt % of modeled melt compositions derived from basalt (B) and peridotite (P) starting compositions and thermal gradients in the range of 10-25 °C/km (represented by numbers). Vertical dashed lines represent Venera 13 and 14 measurements and the corresponding horizontal lines indicate 2σ errors. The gray box indicates the range of crustal depth (~21-60km) for all thermal gradients considered.