**High Temperature Seismometer, Electronics, and Sensor Development for Venus Applications,** G. W. Hunter[1], G. E. Ponchak[1], G. M. Beheim[1], P. G. Neudeck[1], D. J. Spry[1], M. C. Scardelletti[1], R. D. Meredith[1], B. Taylor[2], S. Beard[2], and W. S. Kiefer[3]
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**Introduction:** Venus has significant similarities to Earth in terms of size, initial composition, and solar-radiative influences. However, its present planetary conditions contrast drastically from that of Earth with a significant greenhouse effect. Venus has a very hostile environment with an average surface temperature of 462°C, an atmospheric pressure of 90 atm on the surface, and an atmosphere comprised primarily of $CO_2$. Missions that have landed on the surface of Venus have typically lasted on the order of hours due to the high temperatures and harsh conditions. Further, the measurement of Venus planetary conditions has generally been limited by the lack of sensor, instrument, and electronic systems that can operate long term in the harsh Venus environment. This paper describes work to develop long-lived seismometry, high temperature electronics, and sensor technologies operational on the Venus surface.

**Venus Seismometry:** One set of measurements that has significant scientific interest is Venus seismometry. Seismometry can help determine the activity of the interior of Venus and provide clues related to its history and evolution. A high temperature Venus seismometer does not exist at this time. Previous efforts have aimed to develop such a Venus seismometer.

The Venus seismometer system has a mechanical structure with a transducer to interface with the planetary environment, as well as signal conditioning and wireless communications electronics. A leaf-spring seismometer design is used. The mechanical structure and transducer are designed for harsh environment operation at 500ºC. The signal conditioning and wireless electronics are based on high-temperature-operable silicon carbide (SiC) electronics.

The technologies associated with a proof-of-concept high temperature seismometer design have been demonstrated. This included the basic transition of a standard and well-accepted seismometer design to a high temperature analog, operation of the seismometer structure at Venus temperatures, and a circuit operational at Venus temperatures that responded to changes in motion of the seismometer position sensor and wirelessly transmitted that data over extended times (24 days). This work is a foundation for further seismometer development.

**High Temperature Electronics and Sensors:** A significant enabling technology for a Venus seismometer and other surface technologies is high temperature electronics. Silicon (Si) based electronics do not operate at Venus temperatures. This implies the use of wide bandgap electronics, such as silicon carbide (SiC). Basic SiC electronic circuits have shown the capability to operate at Venus relevant temperatures for extended periods of time ].

Recent work has been concentrating on providing increased circuit complexity with extended lifetimes. Circuits such as Ring oscillators, 2-Stage operational amplifiers, 4-Bit digital/analog circuits, radio frequency transmitters, and a demonstration of a minimal memory circuit are currently being processed. These circuits represent a medium level of circuit integration complexity and, if operational for extended periods of time at 500°C, would enable a range of expanded capabilities.

Further, a variety of high temperature sensors technologies are being developed and tested for harsh environments, which have Venus relevance. This includes the capability to measure a range of physical and chemical parameters. These sensors have demonstrated high temperature operation, and can provide a range of measurements to enable, for example, a Venus meteorology station. It it concluded that present developments in seismometry, high temperature electronics, and sensors have the potential to enable new Venus surface missions. These capabilities need to be demonstrated in relevant environments, such as that provided the Glenn Extreme Environment Rig (GEER) described in another poster.