

SUBSOLIDUS SHOCK-INDUCED REDUCTION OF  $\text{Fe}^{+2}$  ON THE LUNAR SURFACE: AN EXPERIMENTAL ASSESSMENT. Charles B. Sclar, Jon F. Bauer\* and Robert L. Kastelic, Department of Geological Sciences, Lehigh University, Bethlehem, PA 18015.

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Through study of the lunar samples we have marshalled evidence to support the hypothesis that shock-induced adiabatic heating of  $\text{Fe}^{+2}$ -bearing minerals, such as orthopyroxene, may result in the development of metallic iron plus other phases (1,2,3). Furthermore, we have proposed that the mechanism of shock-induced reduction involves electron transfer between non-volatile species through reduction-oxidation reactions such as  $3\text{Fe}^{+2} \rightarrow \text{Fe}^0 + 2\text{Fe}^{+3}$  (3). In order to assess the validity of the shock-reduction hypothesis, we are carrying out a series of shock-recovery experiments on samples which have been equilibrated at elevated temperature (1150-1200C) and in a controlled atmosphere ( $f\text{O}_2$ ) which simulates the lunar environment. After high-temperature equilibration, the samples are sealed in silica glass to prevent contamination with the terrestrial atmosphere. The study of such equilibrated, shocked, and recovered samples should provide a test of the hypothesis of shock-produced metallic iron on the moon.

It is difficult to equilibrate a sample at high temperatures at a known  $f\text{O}_2$  and then seal it off for subsequent shock experiments using a conventional gas-mixing furnace assembly. We have redesigned the apparatus of Williams (4) to meet these special experimental requirements (Figure 1). The assembly incorporates (1) a standard gas-mixing system with a horizontal high-temperature tube furnace which is mounted on wheels and rails so that it can be moved laterally a distance of several feet, (2) a long horizontal thick-walled silica glass tube coaxial with the tube furnace which serves as the sample-equilibration chamber at high temperature, and (3) a solid-ceramic electrolyte (Y-doped  $\text{ZrO}_2$ ) which is used to monitor the  $f\text{O}_2$  of the gas stream. The sample, in the form of a pill, is placed between two short lengths of close-fitting silica-glass rod. Thin discs of high-purity BN are used to separate the flat faces of the sample from the silica-glass rod in order to minimize chemical contamination and reaction. After high-temperature equilibration in a stream of mixed gases ( $\text{H}_2\text{-CO}_2$ ) at a defined  $f\text{O}_2$ , the furnace is moved laterally while the gas flow is maintained, the sample chamber is then flushed with argon and evacuated with a vacuum pump, and the sample is sealed off with a microtorch by fusing the inner wall of the silica glass tubing to the silica glass rod on either side. The resulting dimensions of the sealed silica-glass cylindrical capsules can be controlled by varying the O.D. of the silica-glass tube and the height of the sample pellet. The terminal faces of the cylindrical capsules are cut parallel to each other with a thin diamond cut-off blade. This simple scheme is a combination of the conventional high-temperature gas-mixing furnace apparatus with the classical sealed silica-tube technique.

SHOCK-INDUCED REDUCTION OF  $\text{Fe}^{+2}$ 

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We have synthesized ulvöspinel, ilmenite, ferropseudobrookite, and armalcolite in the form of pellets from high-purity reactants ( $\text{Fe}^0, \text{Fe}_2\text{O}_3, \text{TiO}_2$ , and  $\text{MgO}$ ) by means of the gas-mixing furnace at temperatures between  $1000^\circ\text{C}$  and  $1200^\circ\text{C}$  and  $-\log f\text{O}_2$  between 11 and 12. After characterization for single-phase purity, the synthesized samples were then equilibrated at temperatures between 1150 and  $1200^\circ\text{C}$  at a known  $f\text{O}_2$  defined by  $\text{H}_2\text{-CO}_2$  mixtures ( $-\log f\text{O}_2$  between 11 and 12), flushed with argon, degassed with a vacuum pump, and finally sealed off in silica glass. Two sets of samples (O.D. 12 mm; height  $\pm 12$  mm) are scheduled to be shock-loaded with chemical explosives at peak pressures of 10 and 30 GPa (100 and 200 Kb) in January, 1978. The results of a microscopic study of the recovered samples will be reported at the Ninth Lunar Science Conference. Miniaturized encapsulated samples which are compatible with the geometrical constraints of the ballistic gun facility at J.S.C. are in preparation. Subsequent experiments will be carried out on members of the forsterite-fayalite series and the enstatite-ferrosilite series, if the results obtained with these relatively simple iron-titanium oxide samples are encouraging.

## REFERENCES

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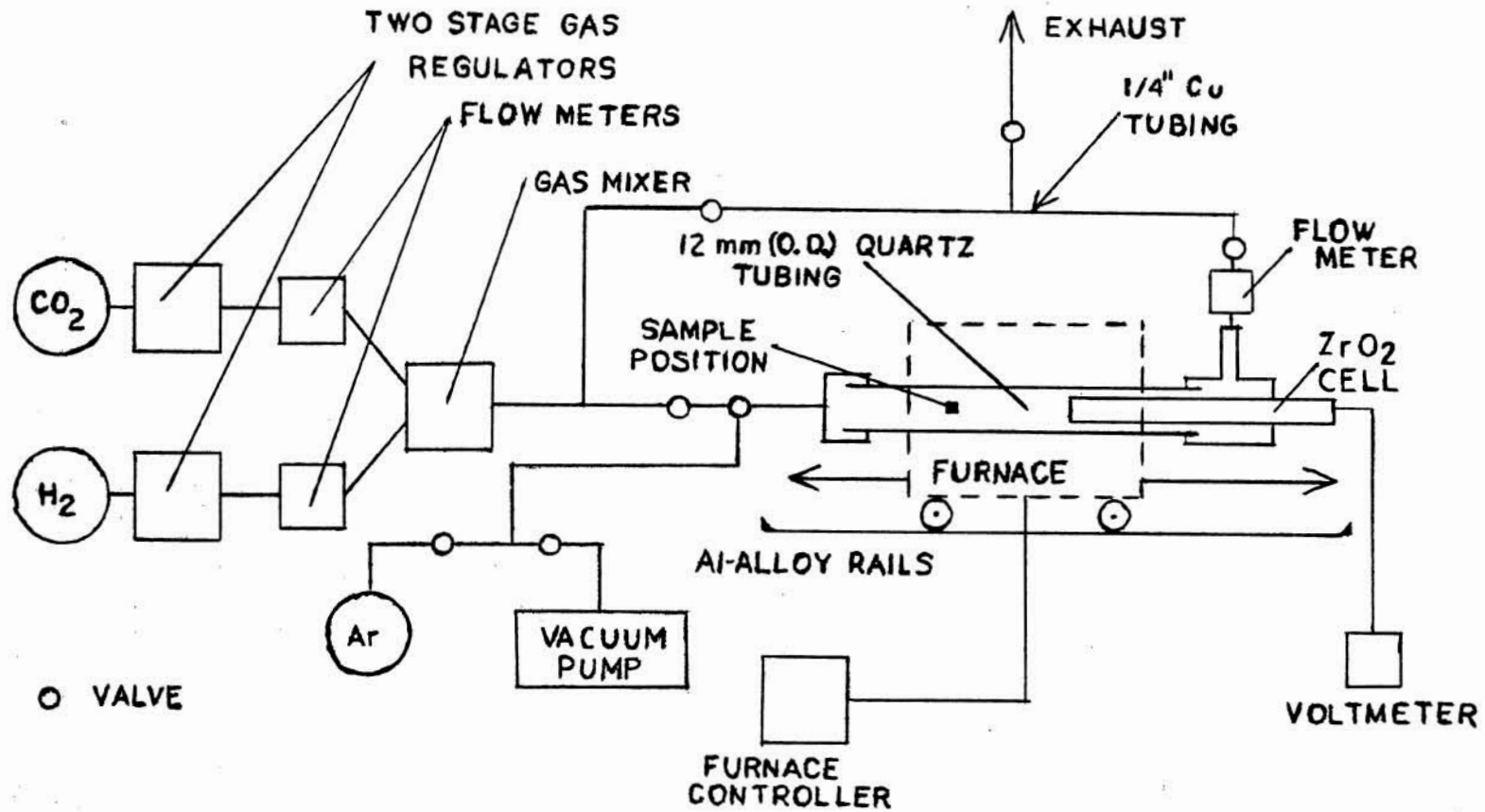


Figure 1. Schematic diagram of gas-mixing furnace assembly for encapsulation of samples following equilibration at high temperature and a known  $fO_2$ .