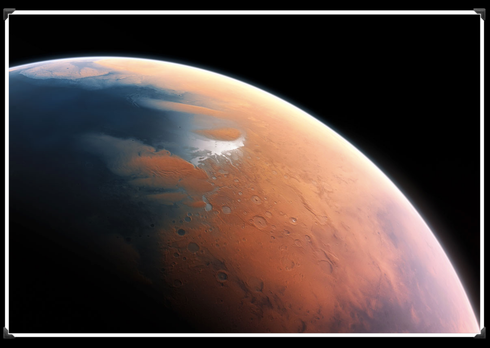
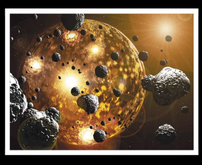
THERE IS PERVASIVE EVIDENCE FOR SURFACE LIQUID WATER 3.8 BILLION YRS AGO ON MARS

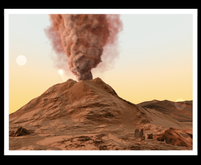


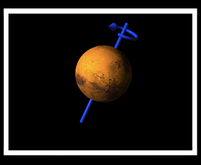
Masursky+1977
Cabrol and Grin 2001
Irwin+2008
Hynek+2010
Goldspiel & Squyres 1991
Poulet+2005
Grotzinger+2015
.... and many more!

BUT HOW WAS THIS POSSIBLE?

Segura+2012
Halevy+2015
see DPS poster:
220.29 Steakley+
Next talk:
404.09 Turbet+



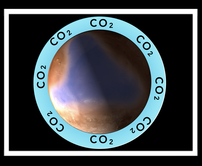


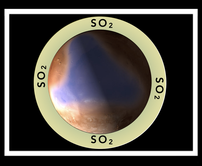


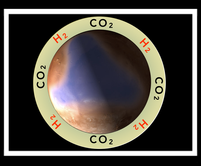
Forget+2013
Kite+2013

Wordsworth+2013
Halevy+2015

Kasting 1991
Tian+2010
Wordsworth+2010
Wordsworth+2015

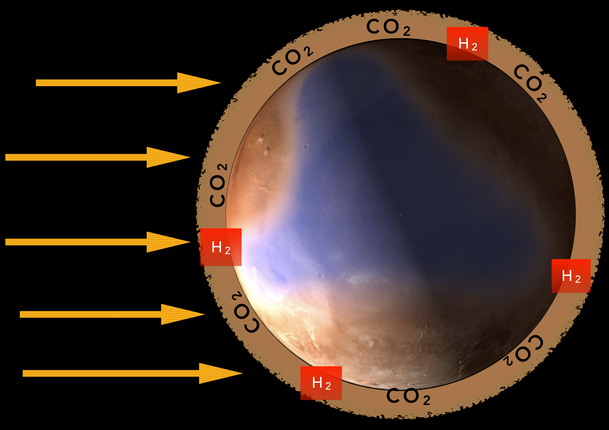




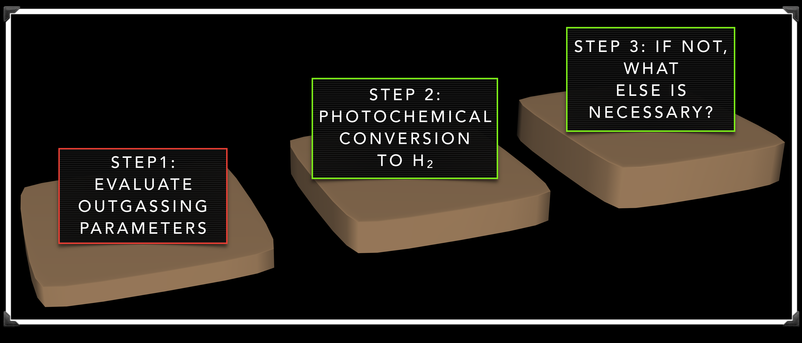


Ramirez+2014
Batalha+2015
Kerber+2015
Tian+2015

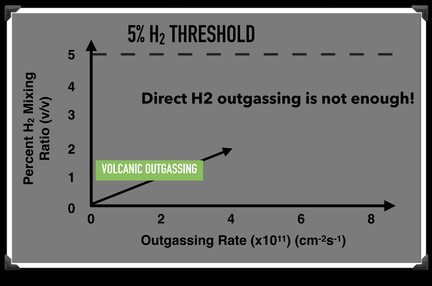
WE FOCUS ON TESTING THE HYPOTHESIS THAT EARLY MARS WAS WARMED BY A THICK H_2-CO_2 GREENHOUSE ATMOSPHERE

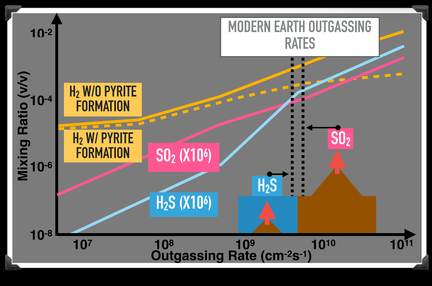


WE ASK: WHAT IS NEEDED TO SUSTAIN A 5% H_2 ATMOSPHERE ON EARLY MARS?

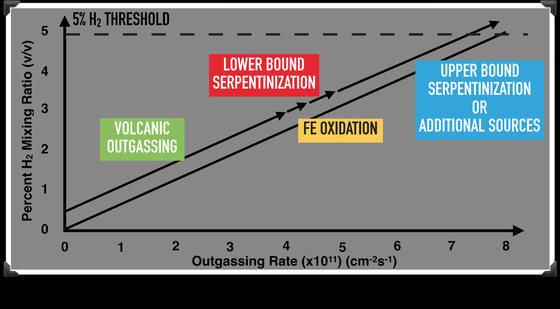


WE FIND THAT INJECTING DIRECT OUTGASSING IS NOT ENOUGH!





WE DEFINE WHAT ELSE IS NECESSARY FOR THE H_2-CO_2 GREENHOUSE HYPOTHESIS TO WORK



Fe Oxidation	Serpentinization
BIFs 	Peridotite + H_2O → Serpentinite + H_2 $3FeO + H_2O$ → $Fe_3O_4 + H_2$