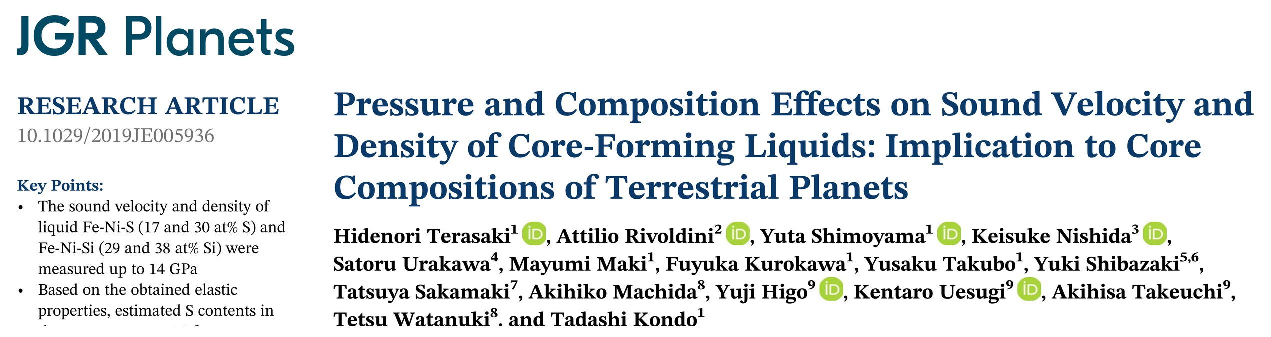
Update on interior structure models

Attilio Rivoldini, Observatoire Royal de Belgique

New thermodynamic model for liquid-Fe-S alloys: Terasaki 2019


JGR Planets

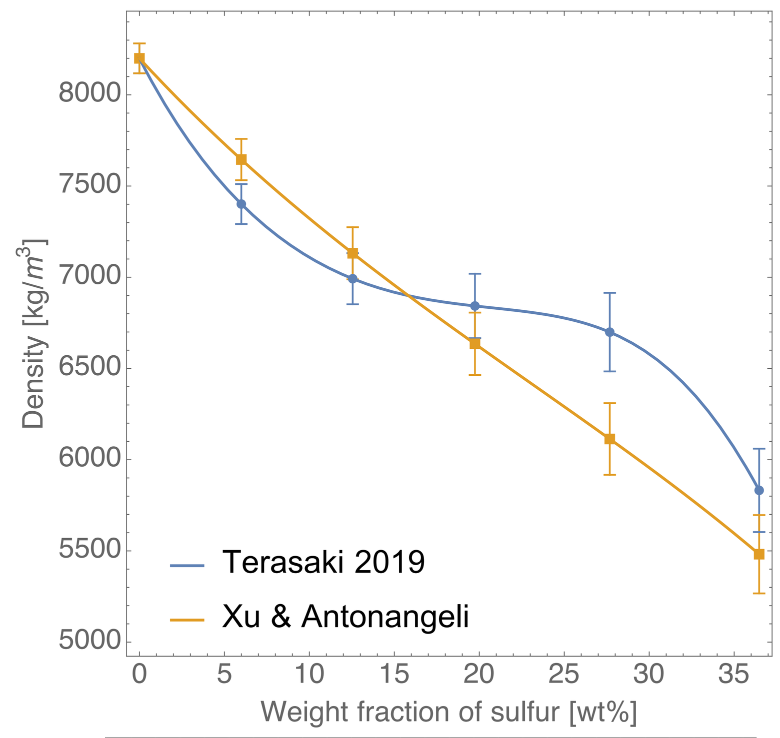
RESEARCH ARTICLE
10.1029/2019JE005936

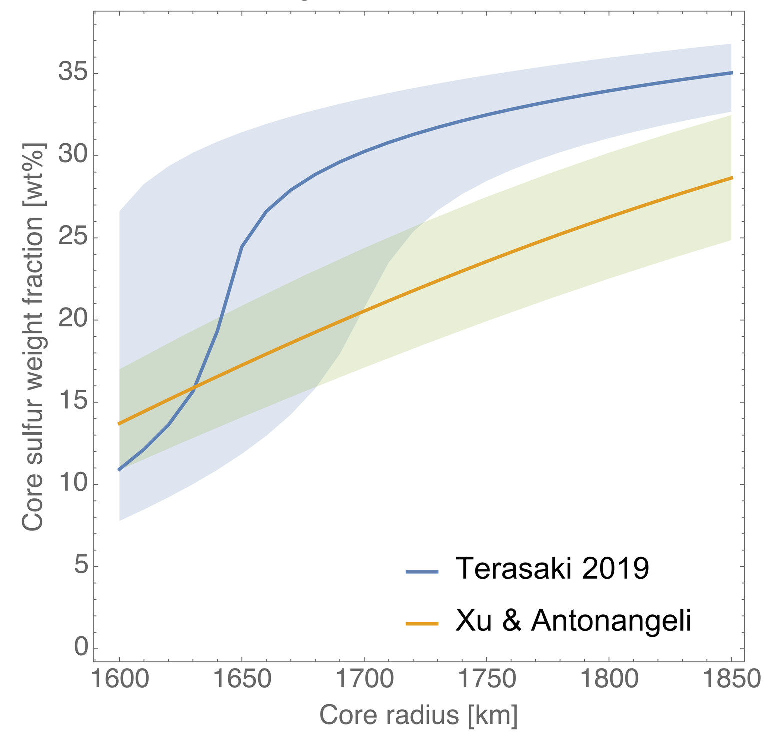
Key Points:
- The sound velocity and density of liquid Fe-Ni-S (17 and 30 at% S) and Fe-Ni-Si (29 and 38 at% Si) were measured up to 14 GPa
- Based on the obtained elastic properties, estimated S contents in

Pressure and Composition Effects on Sound Velocity and Density of Core-Forming Liquids: Implication to Core Compositions of Terrestrial Planets

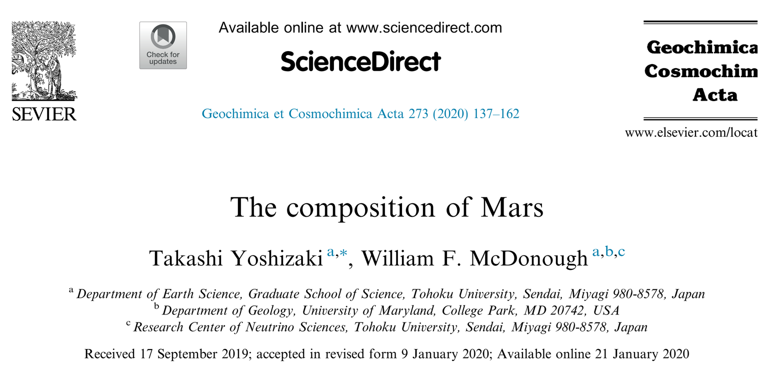
Hidenori Terasaki[1], Attilio Rivoldini[2], Yuta Shimoyama[1], Keisuke Nishida[3], Satoru Urakawa[4], Mayumi Maki[1], Fuyuka Kurokawa[1], Yusaku Takubo[1], Yuki Shibazaki[5,6], Tatsuya Sakamaki[7], Akihiko Machida[8], Yuji Higo[9], Kentaro Uesugi[9], Akihisa Takeuchi[9], Tetsu Watanuki[8], and Tadashi Kondo[1]

- based on measured densities (up to 5 GPa) and acoustic sound velocities (up to 14 GPa) of liquid ($Fe_{73}Ni_{10}S_{17}$, $Fe_{60}Ni_{10}S_{30}$), liquid Fe eos (Komabayashi 2014), and density (Morard 2018) and acoustic sound velocity of FeS (Nishida 2016)
- predicted low and high pressure elastic properties are in good agreement with previously measured low pressure and high pressure density and acoustic sound velocity data (Morard 2013, Kawaguchi 2017)
- is in good agreement with thermodynamic model based on density data of Xu & Antonangeli and other low and high pressure thermoelastic data (Morard 2013 & 2018, Nishida 2016, Kawaguchi 2017) if sulfur concentration is ≲16wt%
- but denser for larger sulfur concentration >16wt%
  ⇒ requires about 10% more sulfur for a given core radius if core radius is large
- both thermodynamic models require core sulfur concentrations that are significantly above concentrations deduced from cosomochemical and formation models
- Fortran code implementing thermodynamic l-Fe-S model of Terasaki 2020 available on UCLA server





New bulk composition model of Mars: Yoshizaki 2020


Available online at www.sciencedirect.com
ScienceDirect
Geochimica et Cosmochimica Acta 273 (2020) 137–162

The composition of Mars

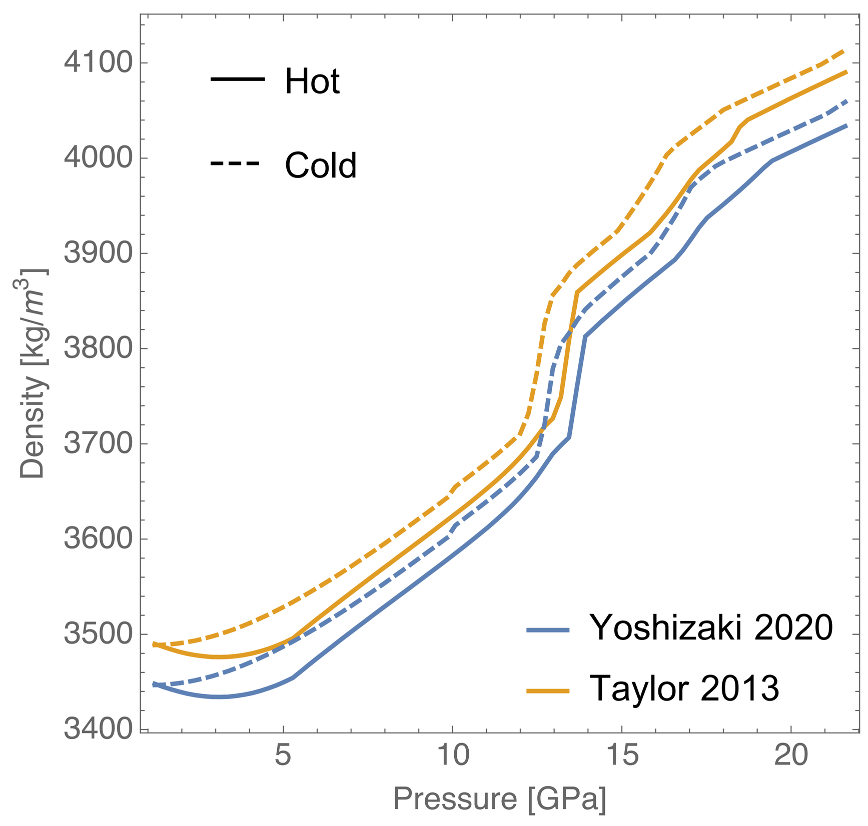
Takashi Yoshizaki[a,*], William F. McDonough[a,b,c]

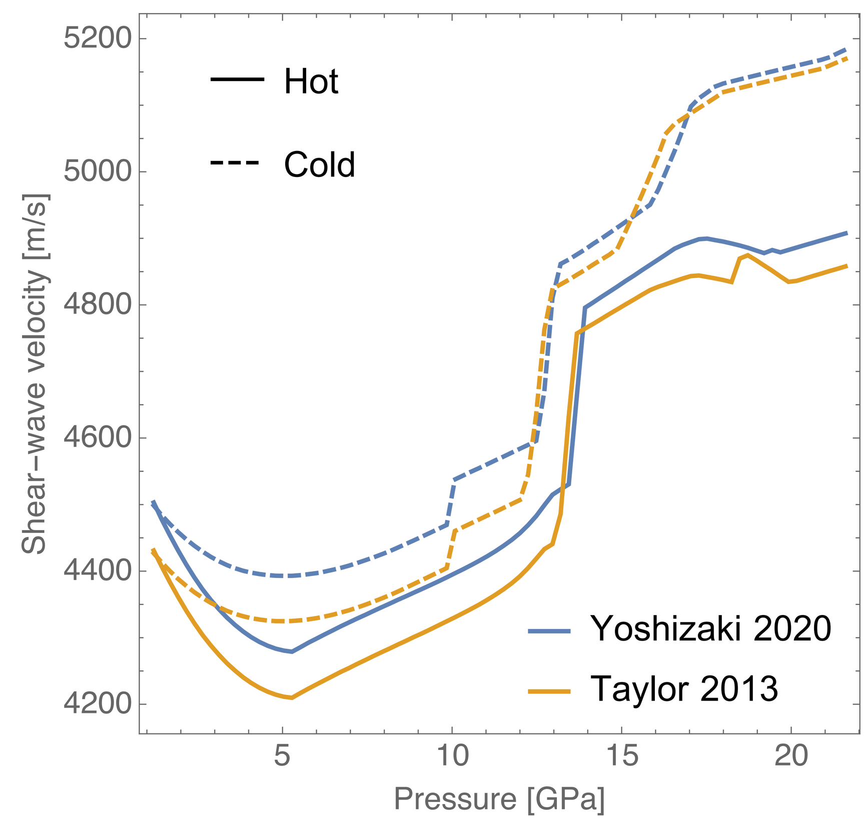
[a] Department of Earth Science, Graduate School of Science, Tohoku University, Sendai, Miyagi 980-8578, Japan
[b] Department of Geology, University of Maryland, College Park, MD 20742, USA
[c] Research Center of Neutrino Sciences, Tohoku University, Sendai, Miyagi 980-8578, Japan

Received 17 September 2019; accepted in revised form 9 January 2020; Available online 21 January 2020

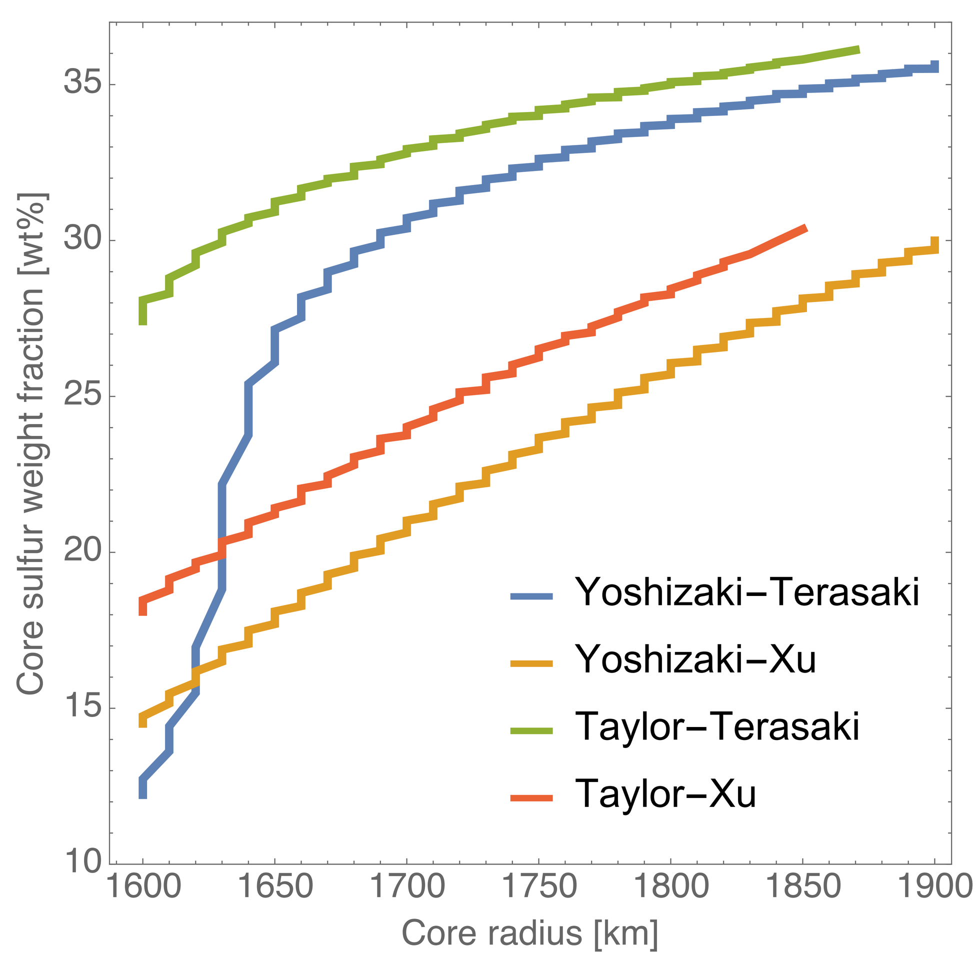
- based on data from Martian meteorites and spacecraft observations
- does not assume that refractory lithophile elements in BSM occur in CI chondritic abundance (unlike D. W. family of models)
- has less FeO than D. W. models and therefore a less denser mantle (affects moment of inertia and core light element concentration)
- BSM HPE composition similar to D.W. models
- core sulfur concentration ≲7wt% (requires O and H to match core mass)

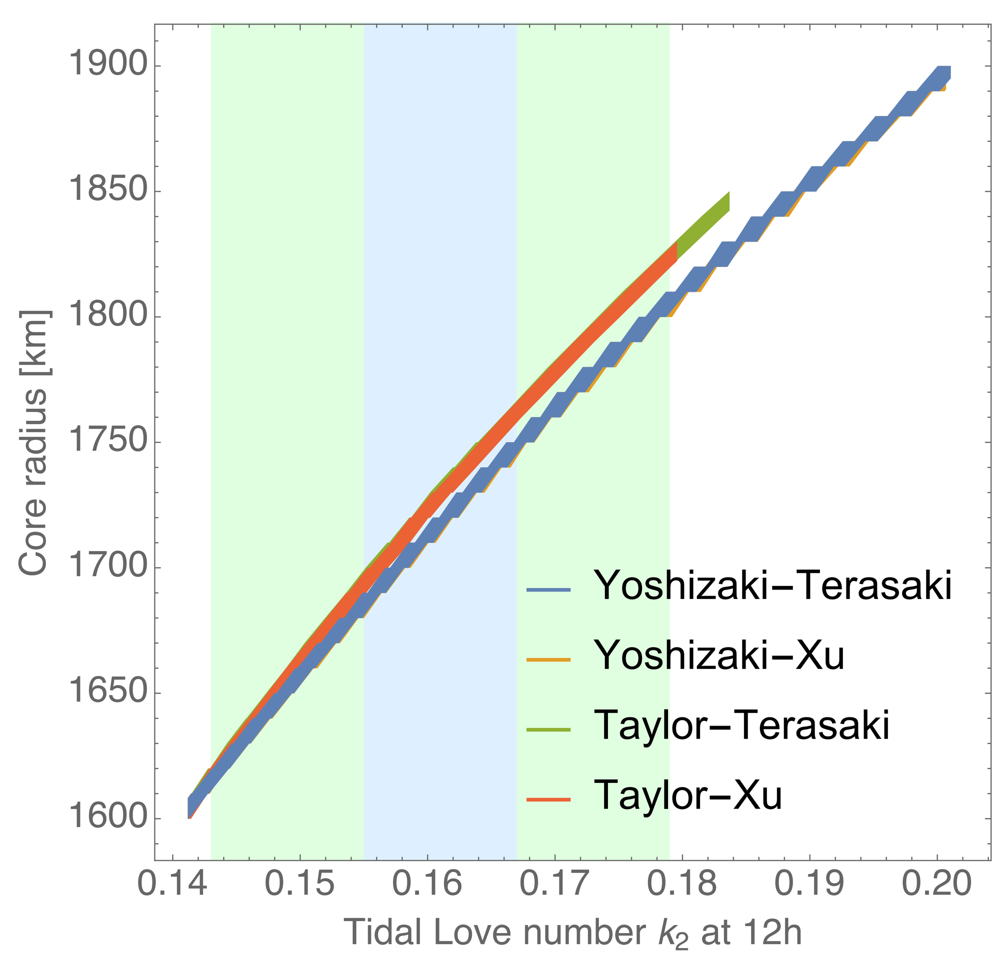
	Na_2O	CaO	FeO	MgO	Al_2O_3	SiO_2
Taylor	0.53	2.43	18.10	30.50	3.04	43.70
Yoshizaki	0.59	2.88	14.70	31.00	3.59	45.50

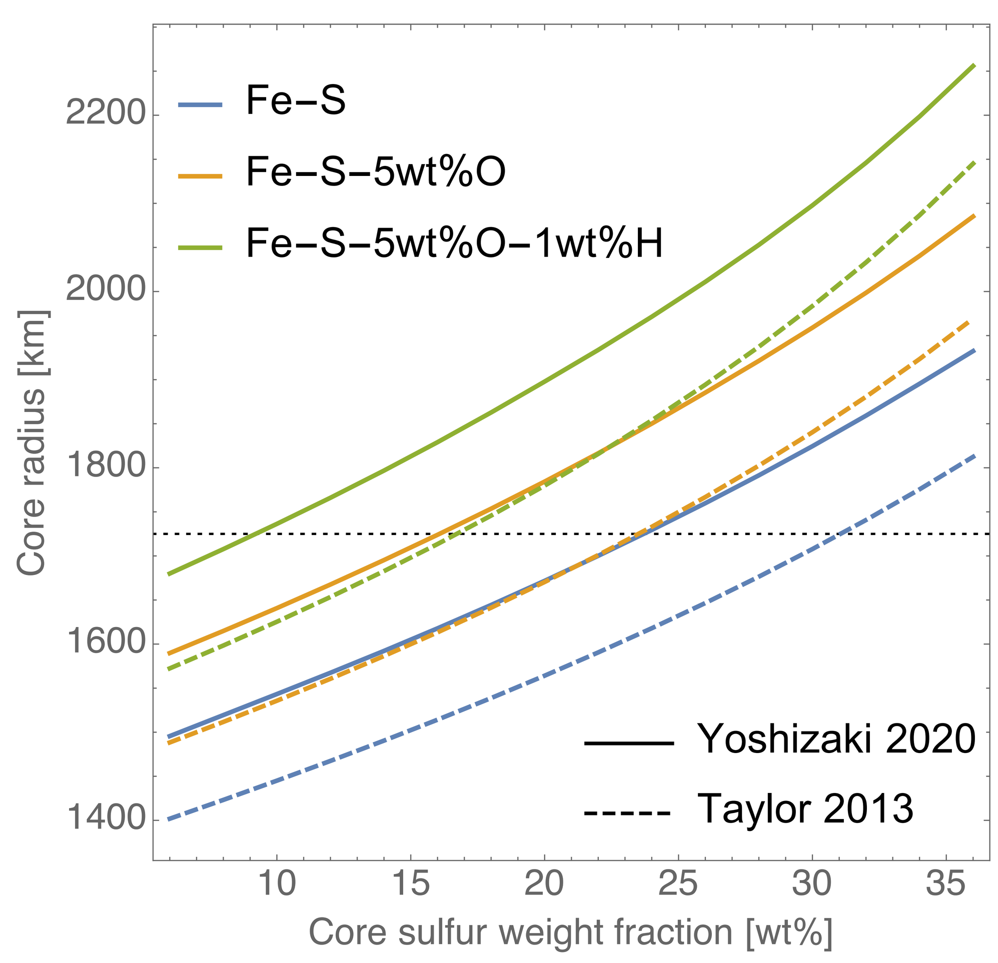




Effect on Mars interior structure







- large uncertainties about thermoelastic properties of liquid Fe alloys and thermodynamic modeling induce a large uncertainty on the core composition
- the addition of a few wt% of O and H brings the required amount of S in the core in line with Mars bulk composition models
- models with S concentration close to that of FeS can have a solid FeS layer below the core-mantle boundary of several hundredth's of km