SEARCHING FOR TRANSIENTS OR A FRESH CRATER AT THE ORIGIN OF INSIGHT'S LARGEST MARSQUAKE. B. Fernando[1], I.J. Daubar[2], P. Grindrod[3], A. Stott[4], A. Al Ateqi[5], D. Atri[5], S. Ceylan[6], C. Charalambous[7], J. Clinton[6], E. Hauber[8]; T. Kawamura[9], J. Liu[10], A. Lucas[9], R. Lorenz[11], C. Perrin[12], S. Piqueux[13], S. Stähler[6], C. Wilson[14], N. Wojcicka[7], D. Giardini[6], P. Lognonné[9], W.B. Banerdt[13]

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Introduction: On May 4, 2022 NASA's InSight Mars mission recorded its largest marsquake so far, with an estimated magnitude of 4.7 [1]. This event was labelled as S1222a and displayed characteristics spanning all previously identified marsquake families.

Aim: to determine whether the S1222a event is of meteoroid impact origin, through identification of a fresh crater from orbit.

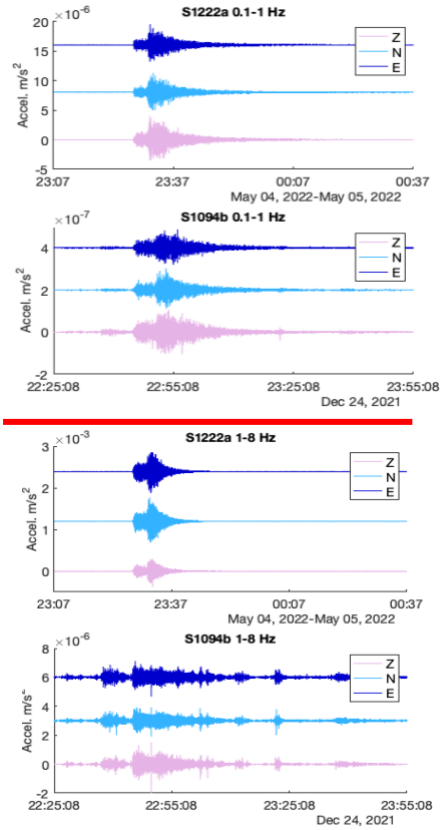

Figure 1: Seismograms for S1222a (top and third panels) and confirmed impact event S1094b (second and bottom panels); upper between 0.1 and 1 Hz, lower between 1 and 8 Hz.

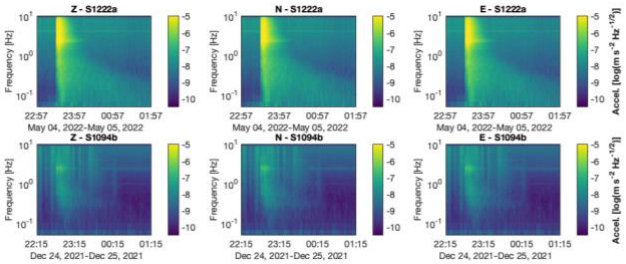

Figure 2: Acceleration spectrograms for S1222a (top) and S1094b (bottom), between 0.1 and 10 Hz.

Similarity to other impact events: The presence of energy across broad frequency range bore some similarities to the broadband (BB) events S1000a and S1094b, both of which were recorded in 2021 and are the only other events with clear surface wave signatures [2]. Both S1000a and S1094b were later identified as meteoroid impact events, associated with craters in the 130-150m diameter range [3].

Comparisons of the seismograms and spectrograms between S1094b and S1222a are shown in Figure 1. Although the S1222a event has a much higher signal-to-noise ratio, and a longer duration, commonalities are still apparent. These include the broad range of excited frequencies, the presence of surface waves, and the extended codas on all three events.

Given these commonalities, we explore the possibility that the S1222a event is of impact origin by undertaking a comprehensive search of the area from orbital imagery, backed up with secondary analysis of pressure wave data from two rover missions.

Search theory: with most of the impact events recorded by InSight [4], the main challenge in associating a new candidate seismic event with a fresh crater has been the difficulty of finding said fresh craters in orbital imagery. For all but the largest two impacts, the craters are of the order of ~10m diameter or smaller, with blast zones extending up to a few tens or hundred metres away. These are only resolvable in medium-to-

high resolution images (for example from the ExoMars Trace Gas Orbiter's CaSSIS instrument), which are captured over any given area of the martian surface at low cadence (months to years).

The two larger events could be more accurately dated as the blast zones are large enough to be seen in the high-cadence (hours to days) global-scale images of the surface taken from orbit (for example, from Mars Reconnaissance Orbiter's MARCI instrument).

If S1222a were an impact event, its blast zone would almost certainly have been large enough to be seen from orbit. Furthermore, any transients associated with the impact (for example a large dust cloud) may have been large enough to be captured by very high cadence, low-resolution webcam-type instruments in orbit, for example Mars Express' VMC.

As such, three potential avenues to associate S1222a as an impact event are apparent. These are:

1) Identification of the fresh crater itself, by comparison to a previous surface image captured prior to 2022-05-04. Even given the size (~140m or larger) this crater would be required to have given the magnitude of the seismic signal, this would still require medium-to-high resolution imagery.
2) Identification of the fresh blast zone, through detection of fresh dark spots in low-resolution, high-cadence images of surface.
3) Detection of transient atmospheric events such as dust plumes via webcam-type images acquired from orbit.

A multi-mission, international search effort was mounted to search for a potential crater associated with S1222a. The following missions and instruments were involved. The missions involved are detailed in Table 1.

Summary: This work will present the results of our multi-mode search for a potential crater associated with the S1222a event.

To the best of our knowledge, this is the first Mars scientific investigation involving this number of missions and international partners.

Spacecraft	**Operator**	**Instrument**
Mars Reconnaissance Orbiter (MRO)	NASA	HiRISE (high-resolution camera)
Mars Odyssey (MOY)	NASA	THEMIS (medium resolution visual/IR camera)
Tianwen-1	CNSA	MoRIC (medium-resolution camera)
ExoMars Trace Gas Orbiter (TGO)	ESA	CaSSIS (high-resolution camera)
Mars Express (MEX)	ESA	VMC (low-resolution camera)
		HRSC (high-resolution camera)
Emirates Mars Mission, Hope (EMM)	UAESA	EXI (low-resolution camera)

Table 1: instruments and missions involved in the search for a crater or transient associated with the S1222a event.

References:

[1] Kawamura et al, GRL 49
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https://doi.org/10.1126/science.abq7157
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https://doi.org/10.1126/science.abq7704
[4] Garcia et al, Nature Geoscience 15
https://doi.org/10.1038/s41561-022-01014-0

Acknowledgements:

We are also grateful to Dr A.S. Arya and the ISRO Mars Orbiter Mission (Manglayaan) team for assisting in this search. Manglayaan's mission ended shortly after the S1222a event and no relevant images were acquired.