FOSSIL METEORITES IN ORDOVICIAN SEDIMENTS FROM SWEDEN ARE NOT REDISTRIBUTED METEORITES FROM A SINGLE FALL. P. R. Heck[1], B. Schmitz[2], M. M. M. Meier[3] and R. Wieler[3], [1]Chicago Center for Cosmochemistry and Department of the Geophysical Sciences, The University of Chicago, 5734 South Ellis Avenue, Chicago, IL 60637-1433, USA. [2]Department of Geology, University of Lund, Sölvegatan 12, SE-22362 Lund, Sweden. [3]Institute for Geochemistry and Petrology, ETH Zurich, NW C84, CH-8092 Zurich, Switzerland.

Introduction: There are many independent lines of evidence that the fossil meteorites found in Ordovician limestone at different quarries in Sweden originated in the L chondrite parent body event and arrived over a time period of about 5 Myrs [1–8]. Many observations clearly exclude the possibility that the meteorites arrived on Earth in a single shower and were later redistributed in the sediment [1–7]. Nevertheless, [9] recently claimed a single meteorite shower as the origin of the fossil meteorites. In the following we will summarize the independent lines of evidence and discuss why a single meteorite shower as the source of the fossil meteorites can be ruled out.

Discussion: 1. The forty fossil L chondrites found at Thorsberg quarry in Sweden (Österplana) by Schmitz et al. in 2001 [1] lie on 12 different marine hardground surfaces and therefore represent at least 12 separate falls [1].

2. Conodonts are used to establish biochronology of the different sediment beds. The meteorite-rich sediments at Thorsberg encompass three conodont zones [1]. Redistribution of meteorites would have also redistributed conodonts. However, there are no signs for redistribution of conodonts among the different sediment beds.

3. The fossil L chondrite Brunflo was found in a quarry ~600 km north of Thorsberg in sediments ~5 Myrs younger than the base of the meteorite-rich sediments at Thorsberg [5], [8], [11]. The host sediments belong to the Conodont subzone *E.suecicus/P. sulcatus* and do not show any signs of redistribution with older sediments [5]. Therefore, Brunflo must have arrived on Earth ~5 Myrs after the oldest L chondrites found at Thorsberg. Also, the (paleo-) geographic distance between Brunflo and Thorsberg is ~600 km, much larger than a typical size of a meteorite strewn field.

4. All meteorite-bearing sediment beds at Thorsberg and at Brunflo contain sediment-dispersed extraterrestrial chromite grains of L chondrite composition [2], [8], [11]. These are fossil micrometeorites and contain solar wind noble gases. They must have been exposed in interplanetary space as small particles [7], [12]. A single meteorite shower cannot explain solar wind content in these particles. Micrometeorites were generated as dust during the disruption of the L chondrite parent body in the asteroid belt and arrived on Earth over a timescale of 1-2 Myrs [8], [12].

5. Micrometeorites with L chondrite compositions were also found in several correlated sediment beds of other quarries and outcrops in Sweden and in China [2], [3], [8], [11], [13]. The (paleo-) geographic distances between the different sites alone dismiss the possibility of a single meteorite shower. The same arguments (2–4) as mentioned above also apply to micrometeorites from these other sites.

6. The fossil L chondrites at Thorsberg represent a wide range of petrographic types in about the same proportions as in recent L chondrites from many different falls [14]. Such a variety in petrographic types would not be expected if they were from one fall.

7. Heck et al. [6] found variable exposure ages in different fossil meteorites at Thorsberg. The exposure ages are lowest in meteorites from the base of the meteorite-rich sediments and increase with decreasing sediment age. The sediment ages have been determined with conodont biochronology [2].

8. Furthermore, the exposure age of the meteorite Gullhögen 001 that was found in a quarry ~35 km southeast of Thorsberg [4] is identical with exposure ages of meteorites in the same conodont zone at Thorsberg [7].

In an abstract, Alexeev [9] criticized the validity of the nucleogenic ^{21}Ne correction made in [6]. In contrast to [6] he estimates the Ne-correction from the He concentration. We have shown in [6], [7] that He, in contrast to Ne, has not been quantitatively retained in most chromites and cannot be used reliably to determine either a correction or exposure ages. Our conservative estimate in [6] shows that nucleogenic Ne concentrations are insignificant in most cases. Meier et al. [12] did not find any ^{21}Ne excess in terrestrial chrome spinel grains of the same sediments. This clearly dismisses the possibility of significant undercorrection of nucleogenic Ne in the extraterrestrial chromite grains and demonstrates the validity of the published exposure ages of the fossil meteorites [6], [7].

Chromite grains from the resurge deposit from the Lockne impact structure, ~500 km north of Thorsberg, are identical in oxygen isotope composition as the fossil meteorites and micrometeorites from other sites in Sweden and China. Thus, the Lockne impactor was also a fragment of the L chondrite parent body [15].

The impact occurred ~12 Myrs after the first fragments from the disrupted L chondrite parent body arrived on Earth [13].

Conclusions: The many independent lines of evidence obtained in careful studies, summarized above, clearly show that the fossil L chondrites found in Ordovician sediments could not have arrived on Earth in a single meteorite shower. It is evident that these meteorites were delivered to Earth over a time period of several Myrs after the disruption of their parent body.

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