A MULTIPLE IMPACT EVENT AT THE END OF THE CARBONIFEROUS. B. J. Hamill, Wester Tillyrie House, Milnathort, Kinross, Scotland KY13 0RW. b.hamill@zoo.co.uk

Synopsis: Multiple impact structures have been discovered in the Midland Valley of Scotland. These elliptical structures appear to have been produced by fragments of a large asteroid following a low-angle oblique impact event. Field evidence demonstrates an end-Carboniferous date for this impact, similar to that of several known North American craters and suggesting that this was a global event which may have been implicated in the disappearance of the forests of Laurentia and Laurussia.

Introduction: The sudden disappearance of the forests of Laurentia and Laurussia at the end of the Carboniferous has been attributed to climate change. However, coal-producing forests thrived throughout the Permian in China and Siberia, which were separated from the main Pangean continent at the time [1], suggesting that some other agent was involved.

Two lines of evidence suggest that a multiple impact event was responsible for the deforestation. Analysis of known impact structures [2] shows that three small North American craters of approximately end-Carboniferous date lie (within 1.3 km) on a great circle, suggesting a common provenance. These craters are Decaturville (6 km diam., 300 Ma), Des Plaines (8 km, 280 Ma) and Ile Rouleau (4 km, 300 Ma). A further 8 North American craters have similar ages. These could be secondary impact craters produced by fragments of a larger asteroid which broke up on impact following a low-angle oblique impact event. Statistically, this type of event should have happened at least once in Earth history [3].

Field Observations: A previously unknown impact structure has been found in the Midland Valley of Scotland and is believed to be the site of the primary impact event. It has an elongated elliptical form (18 km by 8 km) and is the Loch Leven basin of East-Central Scotland. It is surrounded on three sides by quartz-dolerite intrusions which were emplaced around the edges of the crater infill and have thus preserved its shape. Vestigial outcrops of impactites are preserved close to the quartz-dolerite and field relationships demonstrate closely similar ages. These constrain the date of the structure to that of the intrusion (290 Ma). Lithologies include suevites, lithic breccias, friction-melt rocks and impact melts. The structure has topographic features in common with lunar low-angle oblique impact structures [4], including lateral terraces and a central ridge which hosts the most highly-altered rocks. Sandstones of the structure contain planar deformation features (PDFs) in quartz and a highly vesicular rock from the central uplift contains both unaltered quartz grains with PDFs and vesiculated quartz grains.

Downrange Structures: Two further probable impact structures have been identified in Central Scotland downrange of the Loch Leven structure. Both are also elliptical in form and were probably produced by spalled fragments of the initial impactor. Identification is based on field evidence and petrologic data (PDFs). One of these structures is partly composed of basalts previously assigned to a widespread "volcanic" suite of the Scottish Midland Valley. If these rocks also prove to be impactites there may well be several more impact structures in central Scotland.

References: [1] Ziegler, A.M. et al., *in* Martini, I.P. (ed) *Late Glacial and Post-Glacial Environmental Changes* (1996), 111-146 (OUP). [2] Grieve, R.A.F. et al. (1995), *GSA Today 5*, 189-196. [3] Schultz, P.H. & Gault, D.E. (1990). *GSA Spec. Pap. 247*, 239-261. [4] Melosh, H. J. (1999), *Impact Cratering,* 25 (OUP).