Changes to the datum and velocity model used for MVO earthquake hypocenters

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1 Summary

The addition of the SPIDERs to the MVO seismic network in June 2014 prompted changes to the elevation datum and velocity model used by MVO in routine location of earthquake hypocenters. This document records the changes implemented in November 2014, following the deployment of the Chance's Peak station (MSCP) which became the new highest station in the MVO network, necessitating the change to a new datum of **$1241m$** asl for all earthquakes from 01 November 2014.

2 Background

Routine location of VT and hybrid earthquake hypocenters at MVO is done via SEISAN, using the supplied location program HYPOCENTER. The parameter file containing the station locations and crustal velocity model is **STATION0.HYP**, which is located in the $\sim /DAT$ directory of the SEISAN installation. Prior to November 2014, since the **TEST(40)** parameter in this file was set 1.0, the elevation datum used for the velocity model and the depths of the hypocenters produced was taken to be the highest station in the network: namely station MBFR at $541m$ asl. This has been the situation since at least 2009 to the author's knowledge, and most probably since 2005 when station MBFR was installed. The velocity model used at this time is depicted in the left hand panel of Figure 1. Whether this is as was initially envisaged is debatable, but the diagram shows how the model defined in **STATION0.HYP** was being interpreted by the location program.

3 The problem

In order to make use of picks from the SPIDER at Chance's Peak (MSCP), deployed on 22 October 2014, changes to the datum and velocity model were necessary, as at around 903m elevation this station is comfortably above the previous highest station of MBFR at 541m. This situation is further complicated by the planned deployment of an
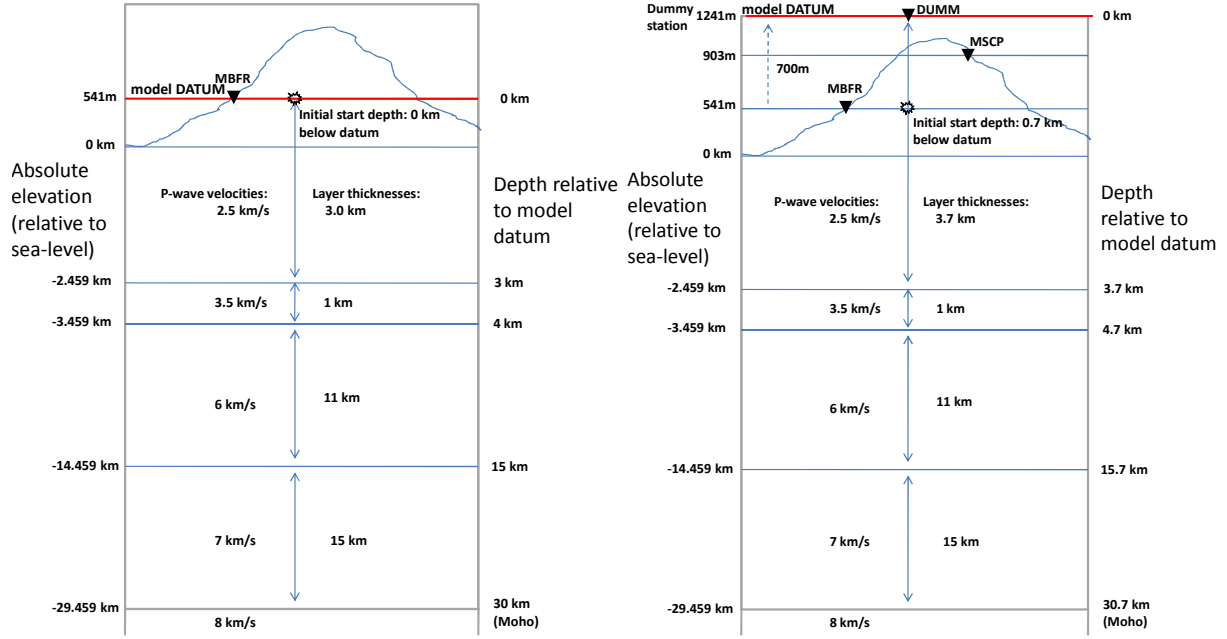
Figure 1: Diagram summarising the changes to the datum and velocity at MVO from November 2014 (not to scale). The left hand panel shows the previous velocity model, with the datum taken to be at 541m - the elevation of the highest station MBFR. The right-hand panel shows the new model that will be used from November 2014, with the datum having been raised by 700m by introducing a dummy station at **1241m** elevation, in order to accommodate the addition of the new SPIDER stations in the MVO network at elevations higher than MBFR.

additional SPIDER on the Eastern side of the current dome (MSDE), at a likely higher elevation than Chance's Peak. Any changes made however, must also seek to retain the current velocity model, by preserving the absolute depths of the interfaces between the different P-wave velocity layers, so as not to introduce artificial changes to the determined hypocenters.

4 Solution: changes implemented in STATION0.HYP

Before making any changes, the current seisan S-files were backed up in a bzipped tar file *REA-pre_20141104_vel_mod_changes.tar.bz2*, which was copied to the 3TB external USB RAID disk on the *seisan* machine and on the *SF1* share of the *volcano01* server. Copies of the existing **STATION0.HYP** configuration were also made.

In order to avoid having to make more than one change to the datum, rather than simply introduce MSCP, a dummy station (DUMM) was introduced (nominally approximately above the dome summit) to be the new highest station in the network and serve as the new datum for the model and hypocenter depths. This station was added to the **STATION0.HYP** file. Despite the format quoted in the manual, the HYPOCENTER program can only accept interface depths in the velocity model to an accuracy of 1 decimal place (100m). Therefore the datum was chosen to be shifted upwards by 700m,

by choosing an elevation for the dummy station of 1241m, i.e. 700m above MBFR. Even with renewed dome growth, a future station at higher elevation than this is not deemed likely.

In order to preserve the depth of the velocity model interfaces, the depth to each interface was shifted downwards by 700m relative to this new datum. This is shown in the right hand panel of Figure 1. A further change was to the initial starting depth used in the inversion algorithm. The version of HYPOCENTER used can be set to take a range of starting depths and then choose the result with the lowest RMS/residual as the preferred solution. The previous setup in the **STATION0.HYP** file used 10 different depths, starting at 0km (relative to the model datum) and incrementing downwards by 1km. Hence in order to preserve this with the new model, the initial starting depth was also shifted downwards by 700m relative to the new datum.

Testing showed that the hypocentral locations of earlier earthquakes (containing no picks from MSCP) were not affected by using this new velocity model; except for the expected downward shift in the depth by 700m to balance the upward change in datum.

The key outcome is that: **all hypocenter depths in the seisan S-files before 01 November 2014 are assumed to be relative to the 541m datum, and all after are relative the new datum of 1241m asl**. Pick information from station MSCP will now be used in hypocentral location from this date forwards.

5   Changes to plotting programs

In order to account for this step change, the two main plotting tools for visualising earthquake hypocenters will need to be updated, with a date criteria for the datum that should be used. These tools are: the *seismic_hypo.m* matlab script on the *webobs* machine which produces the automatic hypocenter plots for webobs, and the *plot_hyp* perl script which produces postscript plots of hypocenters on *seisan* and *piton*. This list is not exhaustive and there are probably other places this will need to changed.