Over 20 diatremes occur in the Missouri River Breaks (MRB) area of north-central Montana (USA) (Hearn 1968 Science 159:622-625). The diatremes and associated alkaline ultramafic intrusions were emplaced at 52-47 Ma and are part of the alkaline province of central Montana (69-27 Ma). The volcanoes are hosted by a sequence of unconsolidated sediments (sands and muds).

Detailed field and laboratory work were performed on pyroclastic deposits from four diatremes during this study. The walls of the diatremes are very steep at the level of exposure. There is strong evidence of subsidence of the mostly bedded diatreme fill. The now bowl-shaped locally feature indications of deposition by base surges. There are also distinct non-bedded pyroclastic units separated from the bedded ones by sharp contacts. We identified huge slivers of sediments, from known formations, which have sunk along the margin of the diatremes. Most pyroclastic rocks contain a large proportion of spherical juvenile pyroclasts (ash to lapilli size, and more rarely bomb size).

These diatremes share some characteristics with classic kimberlite pipes of South Africa, including formation from a low viscosity magma; deep, steep-sided cone-shaped diatremes; the presence of “floating reefs” and mantle xenoliths; sharp pipe margins; cross-cutting pyroclastic units; and spherical juvenile pyroclasts (“pelletal lapilli” in kimberlites). However bedding of pyroclastic deposits is better developed in the Montana examples, even at deep structural levels.

We propose an emplacement model for the Missouri River Breaks diatremes that has implications for the origin of class 1 kimberlite pipes.