



Vombat: an open source proof-of-concept for the use of Digital outcrop models as reference frame for stratigraphic observations

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Three-dimensional Virtual Outcrop Models (VOMs), often produced using terrestrial laser scanning or photogrammetry, have become popular in the Geosciences. The main feature of a VOM is that it allows for a quantification of the 3D geometry and/or distribution of geologic features that range from rock properties to structural elements. This actually generated much of the interest in VOMs by the oil and gas industry.

The potential importance of a VOM in stratigraphy, however, does not seem completely disclosed yet. Indeed outcrops are the primary sources of data for a number of stratigraphic studies (e.g. palaeontology, sedimentology, cyclostratigraphy, geochemistry...).

All the observations are typically reported on stratigraphic logs which constitute an idealized representation of the stratigraphic series, drawn by the researcher on the basis of the features that has to be highlighted. The observations are localized by means of manual measurements and a certain amount of subjectivity in log drawing is involved. These facts can prevent the log from being properly pinned to the real outcrop. Moreover, the integration of stratigraphic logs made by different researchers studying the same outcrop may be difficult.

The exposure conditions of outcrops can change through time, to the point that they can become inaccessible or even be destroyed. In such a case, linking the stratigraphic log to its physical counterpart becomes impossible. This can be particularly relevant when a classical outcrop or even a GSSP is considered.

A VOM may prove useful to tackle these issues, by providing a more objective stratigraphic reference for measurements and by preserving an outcrop through time as a visual representation, thus permitting reference and accurate comparison between observations made through time.

Finally, a VOM itself may contain relevant stratigraphic information (e.g. scalar fields associated with the point cloud as intensity, rgb data or hyperspectral information from passive remote sensing devices). This information requires to be merged with geological data collected in the field, in a consistent and reproducible way.

We present Vombat, a proof-of-concept of open-source software to illustrate some of the possibilities in terms of information storage, visualization and exploitation of outcrop stratigraphic information. Our solution integrates with CloudCompare, a software that permits to visualize and edit point clouds.

A dedicated algorithm estimates stratigraphic attitudes from point cloud data, without the need of exposed planar bedding surfaces. These attitudes can be used to define a virtual stratigraphic section. Composite sections can then be realized defining stratigraphic constraints between different reference frames. Any observation can be displayed in a stratigraphic framework that is directly generated from a VOM. The virtual outcrop, the samples and the stratigraphic reference frames can be saved into an XML file. In the future, the adoption of a standard format (e.g. GeoSciML) will permit easier exchange of stratigraphic data among researchers.

The software constitutes a first step towards the full exploitation of VOMs in stratigraphy, is stored at <http://github.com/luca-penasa/vombat> and is open source. Comments and suggestions are most welcome and will help focusing and refining the software and its tools.