1) Summary

On the 6-7 November 2012, a textural workshop led by Lucia Gurioli, was held at the Maison International of Clermont-Ferrand. The title of the workshop was: "Tracking and understanding volcanic emissions through cross-disciplinary integration: A textural working group". The main objective of the workshop was to gather an expert group to define measurements, methods, formats and standards to be applied in integration of geophysical and physical volcanological data collected during volcanic eruptions. The working group comprised a total of 31 scientists from institutions in France, Italy, UK, Germany and Iceland and included nine expert advisors from the texture field, ten from the deposit analysis, six from the geochemistry and six from geophysics area. The aim was to discuss and define:

- Standards, precision and measurement protocols within the textural field.
- Parameters from textural, field deposit, chemistry and geophysical data that need to be measured and the best delivery format if each discipline's outputs are to be of use to the next.
- Multi-disciplinary sampling and measurement routines, as well as measurement standards.

The group agreed that community-wide cross-disciplinary integration, centered on defining those measurements and formats that can be best combined, is a key global focus. Consequently, we are now preparing a final document that will be used as the foundation for an international textural working group. I intend to base the ethos of this group around our textural group at Laboratoire Magmas et Volcans.

2) Description of the scientific content and discussions at the event

The workshop started with an introduction by Lucia Gurioli for defining the main objectives to discuss during the 2 days:

Syn-disciplinary strategy to measure and constrain explosion dynamics

- The key scientific issues the groups see as current in volcanology (within the sub-group theme area)
- How raw data can be acquired to address these issues (required sampling and measurement strategies as well as precision, errors)
- What parameters need to be extracted from the raw data
- For the parameters define standard data processing techniques (as well as precision, errors, and required assumptions and/or ancillary data)
- How the data should be presented (standards, formats, units)
- What improvements / advances are required

Multi-disciplinary strategy to apply and combine output from each field

- Where in the system diagram do we measure, and where do we not?
- With which parameters within this system do we link to (do we need to be consistent with a precedent process or data layer in the stack, or do we need constraint from another discipline)?
- What issues, raised by our data, cannot be explained using our data alone? Are there any measurements we are making that are not important?
- What are the best data/approach combinations that will constrain our "open questions"?

After this introduction we split into four subgroups: textural, deposits, geochemistry and geophysics. The participants of each sub-group had to use their prepared material to produce a unified power point to define strategies, problems, limits and recommendations for each field, following the points listed above. These points were sent by email a few weeks earlier to allow each component to prepare short power points to share within the subgroup. For each group a chair/spokesperson was chosen as well as a secretary in charge of writing all the discussions. In the following the composition of the subgroups is presented:

- **Deposits** group (chair: Jean-Luc Le Pennec; secretary: Laura Pioli)

(Daniele Andronico, Raffaello Cioni, Jean-Christophe Komorosky, Ulrich Kueppers, Dominique Lafon, Jean-Luc Le Pennec, Raphael Paris, Laura Pioli, Marco Pistolesi, Roberto Sulpizio)

- **Textural** group (chair: Alan Burgisser; secretary: Alison Rust)

(Hélène Balcone-Boissard, Pierre Boivin, Georges Boudon, Alan Burgisser, Sarah Cichy, Lucia Dominiguez, Claudia Doriano, Lucia Gurioli, Alison Rust)

- **Geochemistry** group (chair: Thor Thordarson; secretary: Estelle Rose-Koga)

(Francesca Forni, Patrick Bachelery, Didier Laporte, Estelle Rose-Koga, Olgeir Sigmarsson, Thor Thordarson)

- **Geophysics** Group (chair/secretary: Andrew Harris)

(Jean Battaglia, Andrew Harris, Karim Kelfoun, Jean-François Lenat, Thierry Menand, Lea Scharff)

This section terminated at the end of the first day. In the second day we met all together to listening to the open time-limited four presentations. We started with the deposits group because we agreed that the field knowledge of the system that we are going to study needed to be considered always as the first important step to define precisely. Then we carried on presenting the textural synthesis. After, the geochemistry group presented his summary and the presentations ended with the geophysics.

Deposit group

The group discussion focused only on three main points and considered only tephra deposit, being the deposits usually studied for textural purpose: (i) sampling strategy; (ii) definition of the basic physical properties of the deposit and eruptive parameters which are essential to the study; (iii) estimation of error and variability of field data

Sampling strategy and preliminary field studies

Textural data are extremely time consuming, and usually gathered from a very limited number of clast, usually of lapilli size. The choice of the representative specimens to be analyzed is thus critical when using these data to model eruption processes and their variability. Among the group there was a general consensus on recommending that these studied to be performed only on well-constrained deposits and to develop a sampling strategy based on the goal of the study.

As most of textural studies are aimed in picturing the magma variability and characteristics in the conduit and during fragmentation through the variability of clast properties in the deposit at single locations, it is important to remember that this variability is filtered by sedimentation, which primarily depends on plume dynamics. Volcanic plumes have complex dynamics, which not only do not vary linearly with the main eruption parameters but also depend on external variables, such as wind direction and intensity, determining additional complexity on the clast distribution in the deposit. For this reason, the deposit should be preliminarily characterized at least for stratigraphy, dispersal, thickness variation, volume. Estimation of plume height, eruption duration and magma eruption rate are also recommended.

Selecting the outcrop

The group discussed some basic criteria for the selection of the sampling outcrop, here resumed in three points:

- -To minimize the effect of wind direction, outcrops located along the dispersal axis should be preferred to lateral exposures; in the case of sampling from a single location it is also useful to note variations of proximal/distal layers erupted during different phases.
- -When the goal of the study is the quantification of the proportion of erupted clast types from the deposit, it is important to remember that sedimentation is affected by clast density, shape and size. This is especially important when juvenile types with very different densities are erupted simultaneously: their relative distribution within the deposit can change with distance from the vent (and thus is not necessarily representative of the erupted population), especially in the case of small plumes. When not familiar with the deposit, a preliminary survey of the deposit at different locations is useful for the evaluation of the significance of the type outcrop/s. Obvious variations in clast color, bubble shape, crystallinity, general morphology, and any possible feature determined by post-fragmentation expansion and cooling gradients should be evaluated already in the preliminary field survey, to picture out any lateral and vertical variability in within the deposit and to ensure that, when defining clast types in the laboratory, the main textural types are identified and separated. It is also important to avoid excessive subdivisions, which could unnecessarily complicate the study and might lead to redundant measurements.
- -For these reasons, when the purpose of the study is the characterization of magma properties during different eruption phases it could be more appropriated to sample each tephra layer at different locations rather than selecting a single type outcrop.

Sampling

After having selected the outcrop, it is necessary to get a statistically relevant number of clasts collected at random from the deposit. Several techniques might be used, ranging from sieving in the field to the preferred clast size, sampling of bulk deposit to select clast in the laboratory.

- -The number of samples should be calibrated to the purpose of the study, fixing the number of samples per stratigraphic layer based on the layer characteristics (zoning/ fluctuations of grain-size, componentry) rather than on their thickness which is less relevant in terms of eruption dynamics.
- -Before selecting clasts, basic grain-size studies should be performed on each sampled layer (median and sorting of grain-size distribution) and lithic/juvenile componentry is also recommended. In particular, juvenile componentry ensures that the main categories of textural types are considered in the textural study.
- -Finally, after the choice size of the clasts selected for further measurements (density, porosity, microtextures) is done, it is useful to compare it with the total grain-size of the sampled layers, especially when the grain-size distribution is very variable within the sampled stratigraphy. This will check sample representativity (i.e. sampling from bimodal distributions or anomalously poorly sorted which could be indicative of contamination from other sources, i.e. ballistic components or density currents or reworking).

Measurement error and deposit variability

The group also discussed the necessity to quantify the representativity (in terms of error/ variability) of all the field data. The measurement techniques should be also provided for a correct comparison with existing databases. For some of these parameters (deposit thickness, areal distribution and local grain-size distribution obtained by sieving) measurements are either straightforward or obtained by well-defined procedures and the error quantification is relatively simple. For others parameters (componentry, deposit volume and eruption parameters, total grain-size obtained from image analysis in the case of breccia or welded deposits) the community has not provided well codified procedures and further work is needed. For this reason, the group discussed extensively several techniques used by field scientist, but could not recommend any specific strategy for error quantification.

Textural group

This group discussed several issues related to the textural analyses in terms of:

Representative samples

Because it is assumed that the pyroclasts reflect the state of the magma at the moment of fragmentation and therefore can be used as an indication of the density of the magma at that time, this assumption has three requirements. First, magma has to be quenched immediately after fragmentation to avoid post-fragmentation expansion that will change the clast vesicularity. Second, because juvenile clast density varies with size, only clasts from a restricted size fraction must to be used. Third, the sample has to be representative of the explosion, or unit, in terms of:

- time (i.e. we need to sample narrow stratigraphic intervals in which clasts can be assumed to represent those parts of the magma that were fragmenting at a particular time);
- space (i.e. we need to select more than one section for each event);
- paricle size (i.e. if an explosion is bomb, lapilli or ash dominated, the sampling methodology has to be appropriately selected);
- componentry (i.e. if the juvenile fraction is heterogeneous, the sample has to reflect this heterogeneity).

Traditionally, only clast sizes of 16-32 mm (i.e., lapilli) were, generally, used. Such clasts are large enough to be easily sampled and studied, and can be representative of the density variation of larger clasts. Also, it was thought that clasts of such sizes were not subject to post-fragmentation expansion. However, this size is not always representative of the explosion or of the deposits, sometimes is subjected to post fragmentation expansion and not always reflect the density variations observed in the smaller or bigger clast. Because of that, we listed new indications to follow:

- There is the need to sample the grain size representative of the magma at the fragmentation level. To do this, we need to enlarge the field of observations to cover both the largest clasts (i.e. bombs, >64 mm) and the smallest clasts (i.e. ash, <2 mm).
- For each case-study the challenge will be to identify, quantify and remove post-fragmentation effects so that we can isolate the textures generated on fragmentation.
- Whatever is the size, we should measure clasts of approximately same dimension (so remove potential effects of \phi depending on size when comparing samples).
- Conduit processes can happen on short timescales and so to capture these processes we need to sample on narrow timescale.
- Not all deposits show great variation; density measurements need to be done to assess homogeneity or not.
- Based on this variation, clasts that are more representative of deposit has be chosen;
- Color, grain size, morphology bubble and crystal texture, composition, including volatiles, need to be combined to identify the juvenile clasts.
- Already well-studied deposit helps to give context to textural work.

<u>Comparison between 2D and 3D X-rays approach</u>

There are two contrasting methods for extracting bubble and crystal size distributions in pyroclasts. The first is by conversion of 2D data from a planar surface (such as a thin section or photograph) to 3D data through stereology. The second method is by deriving 3D tomographic scanning (other 3D methods have been not discussed during the workshop).

2D method

- yields high quality data;
- accounts for all bubble sizes in the sample;
- deal with relatively large numbers of samples of different sizes;
- consider a sample that is truly representative of the deposit, or the explosion.
- these measurements are better when there is a broad size distribution
- a standard procedure has been recently published (Shea et al 2010);
- labor intensive;
- it is based on spherical assumption.
- the cost of 2D measurements is often human time

3D method

- computer power increasing and so resolution in 3D is less of an issue
- data acquisition is easy: can do several scales and can go down to very small scale (1 micron) if use sufficiently small sample
- It is helpful to do nested studies (series with different sizes and thus resolutions)
- it shows how objects and apertures are linked together, very good for collapse, permeability, tortuosity and coalescence quantifications
- density contrast still a problem for some applications, especially crystals
- good for number density but not for vesicle size distribution
- de-coalescence is not yet fully functional.
- there is not a protocol yet

We all agree that 2D and 3D are becoming complementary and not competitive.

<u>An automatic process for crystal size distribution</u>

We all agreed that the crystal size distribution (CSD) is an under used tool, that instead should be always provide coupled with the vesicle distribution. This method is well set up and with the new analytical techniquse is quite straightforward to quantify the CSD:

Chemical mapping

- Determine phases, modes, composition, texture (size, orientation, shape):
- Determine modes of minerals and the percentage of them.
- Compile the bulk analysis (combining composition of phases and proportions).
- Quantify heterogeneity (e.g. by mineral ratios)

Electron backscatter diffraction detector (EBSD)

This method uses a scanner and a polarizing filter at different angles. Three pictures are combined and their correlation gives the individual grains classified by orientation. The grains can be contoured. This can be combined with the phase map and gives:

- the shapes of grains of different phases assessed
- crystallographic orientations
- orientation of microlites with just 1 thin section
- zoning and variations in composition with size of microlites

Chemical mapping is now straightforward and takes twenty minutes per sample. The machine can be set to change samples and to run overnight. EBSD is more difficult. It takes hours, but does produce lots of information on various minerals, perhaps too much information. Problems include resolution and the lack of composition contrast between glass and feldspar.

3D tomography depends on the density contrast present. It does not have the resolution and discrimination of chemical mapping in 2D. For basalt this method works well, but not for glass and feldspar in more felsic samples

Volatiles in relation to texture

The overall approach is to use textures with other data to constrain a degassing model. Residual water content is plotted against Vg/Vl where l is melt and microlites and the glass is corrected for phenocryst. The issue is to correct for the post-eruption hydration. Recently, thermal gravimetric studies have proven to be quite good. Oxygen or hydrogen isotopes are best for assessing hydration. What is the meaning of dense texture: are they quenched or collapsed texture? It is important to give the right interpretation because they relate to different mechanisms. In two subplinian eruptions has been found that the densest clast are depleted in water through collapse and coalescence, because of syneruptive processes.

Errors in textural analyses

- Raw data are straightforward;
- the parameters needs a protocol;
- the model dependent needs to be defined;
- make more use of synthetic techniques to assess precision (the input is known; do processing and quantify method errors);
- decompression rate from number density - be careful as number density is the integration of the whole process.

Needs

- Define the representative elementary volume;
- dataset of images, primary and secondary parameters;
- link between textures and water analyses;
- link between crystals and bubbles and the relationships between them (e.g. how close is a bubble to a crystal, which is the relation between bubbles and microlites?)

Geochemistry group

This group started from the observation that (i) all the procedure to acquire data and run experiences are well defined, (ii) all measurements have associated error and error propagations are dealt with systematically and (iii) internet database are already available (e.g. Georoc, Germ…) and incremented on a regular basis. Therefore the contribution of this group appears shorter (but not less important) because a lot of the other groups concerns simply did not apply and therefore the objectives were slightly different and consisted in clarifying the relations of the geochemistry-texture.

This was done by first addressing what geochemistry can provide:

1) Initial parameter (magma storage)
2) Conduit (degassing)

Then identifying where in a textural study, geochemistry can be of help:

- defining the source (in terms of pressure and temperature) from minerals;
- defining the original volatile content (melt inclusions) and combing with vesiculation studies (was it saturated, over-saturated, under-saturated which affects vesiculation in conduit);
- assessing initial viscosity, temperature, melt composition, volatiles, pre-eruptive residence times, mineral diffusion profiles, input of gases from deeper sources;
- measuring residual volatiles in glasses (how well degassed? Does it correlate with vesicularly?);
- detecting (CI, F, S, H2O, $\mathbf{CO_2}$) using electron probe, micro probe and Raman;
- tracing bubble nucleation history (equilibrium vs. disequilibrium);

- providing variable diffusion of elements and used as tracers of degassing and measured by ion probe (6Li, 7Li, H/D), noble gases;
- [same as above], crystal shape (e.g. dissolution stages, what physical parameters affect crystal shape?);
- identifying phenocrysts, antecrysts, xenocrysts

Petrological experiments provide:

- Calibrate decomposition rates (done on rhyolitic system and ongoing studies on basaltic systems);
- nucleation and growing rates of minerals and bubbles;
- couple to numerical models (e.g. length-scales of experimental and natural systems)
- crystal textures and size distributions:
- hopper structure and swallow tail rapid late crystallization (now done qualitatively, should do quantitatively);
- surface flux of volatiles (i.e. what leaves the system) compared with melt inclusion data (i.e. what is in the system initially)

Some open questions and needs:

- Are the microlite content sensitive to composition? (in Islanda microlite content much higher in intermediate (53%) vs. Basalt (5%);
- How to define microlites? Based on size / shape? Or on the CSD shape (discontinuity or bimodality, or changes in slope in);
- Measure composition of microlites (and zoning - stages of magma ascent), size and composition.

Geophysics group

This group focused on geophysical measurements of plume dynamics, and cross-over with textural/deposit studies.

For example, what are the parameters that can be extracted from the data?

Radar, thermal camera / Radiometer , high speed stereo cameras

(i) exit velocity (m/s);
(ii) velocities and velocity distributions of lapilli through to bombs;
(iii) number and size of particles up through a region;
(iv) mass flux and gas flux (kg/s)

Acoustic +thermal + seismic

(v) energy flux (J/s);
(vi) power (J),
(vii) absolute times (s)
(viii) Source location (x, y, z)

Lots of discussion on seismic fluid flux (but what fluid)? Acoustic delay thermal and acoustic but what is sound speed in conduit? Sound speed may not be constant (plume density, particle temperature)

Required assumptions:

- particle size distribution for (i) radar data reduction and for (ii) validate thermal camera and satellite.
- particle density and variation for radar data validation
- magma density for 'empty' part of conduit for acoustic data
- crystals and bubbles size and distribution (and chemistry and temperature) for define magma rheology within the conduit
- drag coefficient (particle size-shape-roughness + gas density in the conduit) for deriving relative velocities of magma and gas What is present just before fragmentation?

Questions: to the textural community

- Can we estimate pressure at the instant before fragmentation (to allow better interpretation of velocity data)?
- Can we estimate strain rate?
- Can we extract anything about conduit shape, dimensions and geometry?

- We need to think about the best geophysical measure to correlate with vesicle number density and other textural measures.
    - initially it probably needs to be a simple measure of energy associated with an individual explosion or pulse
    - later: mass flux (intensity) and/or mass (magnitude).
- What measure of explosion “energy” can we extract from seismic data to add to the integration?(a difficult problem)

Key Science Issues (i.e., those that can be addressed through integration especially with textural data)

(1) We need to test of correlations:

basic measurements (like radiate heat, seismic, acoustic energy and energy fluxes) could be the most straightforward geophysical measurements to consider.

Cross-correlation, and comparison of parameters relating to different processes and cross-correlation between same events (e.g. gas jetting versus impulsive events): allowing us to understand which measures work together under certain conditions; and those that do not.

- In what situations do correlations work, and when/where do they not … why?

(2) We need to understand the links:

what we see and measure at the surface with the magma conditions (through the unknown empty conduit section) with what we measure in the magma column.

In doing this, we need to check that source / explosion mechanism models are valid for all sets of measurements.

For example, how does the time-varying velocity and mass flux distribution related to the number density / vesicle size distribution, and gas flux, and are we able to really explain the link in a confident way?

(3) We need to begin to look at “event groupings”:

Strombolian versus Vulcanian versus sub-Plinian versus Plinian (How do we get the geophysical data for the Vulcanian upwardsfields?)

(4) Ideally we need:

- For each event type: 1000’s of geophysical measurements and coincident samples, for individual, well-defined, explosions (a statistically robust data set).
- We need data (density, size, shape, textural character) for the actual particles that we measure (from proximal to distal).
- Lithic distribution (that could potentially be detected if warmer than sky or colder than hot plume).

(5) In reality we need:

- A site, like Stromboli, that guarantees data source (e.g. small and frequent eruptions), not Plinian or SubPlinian (because it is not feasible?).
- A sample return procedure that we don’t currently have.
- Paricle size distribution, textural results, temperatures that are known to be representative of the event that we are measuring with the remote technique.

In the afternoon we concluded the working group presentations and we made a synthesis of the morning discussions and finalization of sub-group presentations. I animated a full-brainstorming to define (i) the sampling, data collection, experimental and methodological issues; (ii) data and measure that we have and what do we need; (iii) the precision on the measurements, and the standards to apply; (iv) how to improve the measurements / data bases, and collect "missing" data; (v) a community-wide data bank; (vi) how to design a fully integrated field experiment, or provide guidelines to each other regarding key parameters that need to be measured (versus those that are less important) and then input into the data bank, as well as common standards that can be exported from one group to another.

3) Assessment of the results and impact of the event on the future direction of the field

Open questions and problems

- How to derive the total grain size distribution?
- The analog experiments at the moment are very short and not capable of reproducing bubbles growth or coalescence (don't have evolving properties).
- For textural analyses sampling: main axes of dispersal versus lateral? How much do we lose in not looking at variations horizontally?
- How representative is different types of pumice? What is it concentrated in large grain sizes?
- Vesicle number densities from single explosions show wide range. Why?
- How does rheology change? Rate of change which effects eruption intensity. If too fast then may not see it in textures.
- How does microlite crystallisation drive and how does it affect rheology evolution (and rates) that also effects composition of melt?
- Geophysics wants size and roughness data but can/will you really use roughness data (vs. spheres)? Radar modeling using 1 grain size and smooth spheres. How sensitive is the retrieval inversion to these and additional parameters? Sensitivity of model could guide texture researchers to measure and reduce the errors on the most important parameters. Can also use for friction and particle trajectories.
- Following the previous questions, assuming a constant size and not incorporate other existing data is irresponsible. However, we should understand (through sensitivity analysis of models if grain size is more important than roughness?
- Lots of data from Strombolian and Sub-Strombolian (too much data?), almost nothing for larger eruptions.
- Why do mass, velocity and sounds at Stromboli are not correlated?
- Colo' et al. 2010 shows that acoustics is a good indicator of energy. Works in a case (puffs of gas thrust of 4m, no plume). However, seismic and acoustic energy do not always correlate - so which is right one to use?
- How to get together? Design experiment

Suggestions and statements

- For textural purpose helps to study proximal sections along the main dispersal, but it is necessary to think about what expect outside the dispersal axis
- Check density variation with distance. If there is variation, what is the weight of each clast type? (Example Rabaul)
- In large eruptions conduit wall are small effects compared to volume of material erupted (wall effect in narrow ring), but in small eruptions have the opposite. Are you only interested in what happens at the centre of the conduit or in the more sheared part of the conduit?
- Tube pumice may be harder to fragment (high permeability) and so over-represented
- Infrasound community did a large explosion of a known size; we should propose something similar
- Geophysical signals are averages (e.g., tremor amplitude) Need single explosion for comparison with texture
- In fragmentation analog experiments only small factor (< 25%) of energy is consumed by fragmentation (the rest used to accelerate particles upwards).

Main Recommendation:

Deposits and fragmentation analog experiments communities

(i) for textural purpose the sample has to be define in terms of (Fig. 1):
    - Grain size
    - Componentry
    - Morphology

(ii) standard methods and derived parameters should be available through data base or repository material attached with articles;
(iii) the sampling should be done on single explosions. To do that array of tephra traps with scales during eruptions can be used, but we should start to investigate the possibility to use sampling systems that opens and closes (for ash rain) as they do in case of normal rain;
(iv) find a standard method to determine the total grain size distribution of tephra deposits;
(v) build a synthetic library for analog experiments;
(vi) link geophysical instruments with large-scale analog experiment.
(vii) based on the several issues that arise from this working group the deposit group realized that they need to set up their own working group

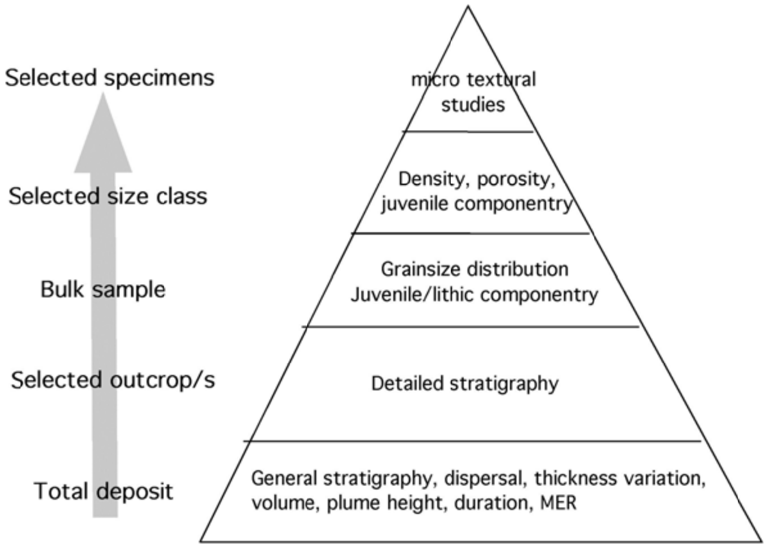

Figure 1 Schematic representation of the sampling procedure for textural studies

Textural community

(i) Sample the grain size representative of the magma at the fragmentation level;
(ii) quantify and remove post-fragmentation effects so that we can isolate the textures generated on fragmentation;
(iii) for each case-study measure clasts of approximately same dimension (so remove potential effects of density depending on size when comparing samples);
(iv) do more detailed studies of selected eruptions (detailed sampling and textural studies);
(v) know global (total) variability of juvenile population;
(vi) Groupings of types of pumice (tube vs normal, crystals vs no crystals);
(vii) quantify the post expansion features;
(viii) work on bubbles and crystals together;
(ix) understand when the correlation between Nv and eruption rate work.
(x) more textural data need on pyroclastic density current and lava flow deposits
(xi) reformat table like Geophysics (parameters, exploratory…)
(xii) produce more permeability and tortuosity data that affect pressure build up and fragmentation;
(xiii) produce more connected versus isolated porosity for out-degassing quantifications;
(xiv) couple textures with other data such as clast morphology, total grain size distribution.
(xv) vesicle number density and total grain size distribution correlation should be performed at eruptions with different distribution of vesicles. Some eruptions are dominated by microvesicules - poorly connected bubbles. Others have wider range of bubble sizes and more connectivity. Need to start by identify end member deposits.
(xvi) E.g select end members to study different pumice (tubular, microvesicular and so on)

Geochemical community

(i) Combine textural and geochemical analyses on the same samples (e.g. the number of bubbles affects disequilibrium calculation), so is a link between texture and geochemistry).;
(ii) correlate degassing (initial volatile contents versus surface gas measurements) with textures;
(iii) combine study with experimental petrology to get key parameters (e.g. partition coefficients, decompression rates…).
(iv) contribution to understanding textures from timescales (e.g. diffusion profiles).

Geophysical community

(i) Research coupling products, grain size, texture and geophysics is great science but to use operationally and for larger eruptions is hard. Won't take thermal cameras to every volcano. Need to concentrate on seismic and acoustics globally.
(ii) If knew there would be a Plinian eruption then could have the radar ready. Iceland have some mobile radars.
(iii) RMS (integrate multiple pulses) in mostly background tremor and not specific explosions.
(iv) Make larger-scale experiment and monitoring experiments (using thermal camera, Doppler etc;).

Common needs

(i) Database of raw data repository.
(ii) Data base that allows huge amounts of cross-correlation, and comparison of parameters relating to different processes and cross-correlation between same events. Data need to be placed on this data base in a format that is useable by each group.
(iii) Geophysically, probably best to also upload least ambiguous data. For example:
    - level 0 data (voltage: no one's going to use it)
    - level 1 data (power: no-to-little bias introduced) (velocity: no-to-little bias introduced)
    - level 2 data (mass: assumptions = bias/error)
(iv) COPRIGHT-PROTECTED access to allow realization of the statistically-representative event library (do we need to progress with data reduction issues?).
(v) Library of data from natural samples to validate remote sensing.
(vi) IAVCEI committee has nothing on textures. Move towards common (IAVCEI-supported) document and field work shop to implement conclusions reached by working group.
(vii) Come up with a uniform sampling procedure and data report procedure that student would be taught and new young scientist, colleague will apply from then on.

4) Final program of the meeting

Tracking and understanding volcanic emissions through cross-disciplinary integration: A textural working group

Clermont-Ferrand 6-7 November 2012

Maison Internationale Universitaire

Schedule

<u>Tuesday 6 November</u>

10.40-11.00 ----- Coffee-----

11.00 **Part 1 (am)**

<u>Introduction:</u>

Presentation to introduce the scientific theme of the working group, as well as our motivation, open questions and objectives (by Lucia Gurioli)

Split into in sub-groups to synthesize **strategies, problems, limits** and **recommendations** for each field, and nominate chair/spokesperson for each sub-group.

The participants of each sub-group will use their prepared material (a few, prepared, PowerPoint slides that address the main issues (as listed in the schedule) in relation to sphere of interest, with a view to incorporating these in the sub-group discussion to which each component will contribute) to produce a unified power point.

Group (1): Textural

Group (2): Deposits

Group (3): Chemistry

Group (4): Geophysics

12.40-14.00 ----- Lunch-----Restaurant du Rectorat

14.00 **Part 2 (pm):**

Working group tasks - continued

16.00-16.20 Tea

Working group tasks - continued

18.00 Retire to the bar, followed by evening meal at Crêperie le 1513

<u>Wednesday 7 November:</u>

9.00 **Part 1 (am)**

Four presentations (working group conclusions & recommendations): open time limit + questions from other groups, no discussion yet

Deposits (by Jean Luc Le Pennec)

Texture (by Alan Burgisser)

10.40-11.00 ----- Coffee-----

Geochemistry (by Thor Thorvardosson)

Geophysics (by Andrew Harris)

12.40-14.00 ----- Lunch----- Restaurant du Rectorat

14.00 **Part 2 (pm)**

Conclusion of the working groups:

Synthesis of morning discussions and finalization of sub-group presentations

Sum up - where is the overlap - what do all groups need and in what format

16.00-16.20 Tea

16.20 **Part 3 (pm)**

Check-out:

Organization of follow-up work

- Preparation/completion of documents and generation of group hub

- Creation of working group information and data sharing node - web-based(?)

- Generation of a written document, supported by science papers written in support of the effort a special issue of BV?

18.00 Retire to the bar, followed by evening meal-----Brasserie du Jardin