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**In This Issue:**

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**Your contributions are required - New Zealand Soil News is your newsletter**

*News, views, letters, articles (serious or otherwise)—send to:*

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**Deadline.....** For the February issue of Soil News is Friday 17th February **2017**

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## Editorial: by Tim Clough

**Get thee to a conference**

Researchers should attend conferences as part of their ongoing career development. But going to a conference involves expense and hard work. So why do it? Costs include travel, accommodation and conference fees. While clearing the diary for a conference week involves preloading work, or else taking it on the road. Confronted with such obstacles it's easy to put it in the 'too hard' basket. But if you do you're missing out on the benefits of conference attendance. The rewards can be significant.

Those more advanced along career pathways, identified by the presence of grey hair, have all, at some point, been inspired by teachers, or mentors. These individuals took the time to provide guidance, motivation and to point those early in their careers in the right direction. A conference allows you the opportunity to give something back. It may be something subtle. For example, if the poster you have just looked at, or the talk you've just listened to, screamed that the author/speaker was unaware of a key publication, quietly suggest that a certain paper would be of interest, or email it to them with appropriate commentary – marked urgent. It's not only the immediate science you can help with, maybe you can advise on science career pathways, job openings or potential collaborators and science networks.

A conference can be a chance to listen to inspiring and gifted speakers, true experts in their respective fields. They'll present to the audience in an erudite fashion, be entertaining, using beautiful images to display their data that some professional artist was paid the equivalent of a PhD stipend to produce. But you'll not register this financial fact, until later when you try to get your own work imaged. Such speakers present their science ever so clearly, in a way you can only dream of. Their esteemed career means they will have earned the licence to be provocative, but with humility, as they constructively question and kick the dogma. Ignore the fact that the motivation and excitement such talks invoke will be quietly leached from you when you return to your underfunded institute and participate in a 'science' funding system requiring preordained outcomes known as milestones. You'll still remember such talks and find yourself revisiting these for inspiration when the going gets tough.

Great speakers are more often than not accessible, unless constrained by time. So get out of your comfort zone and go and introduce yourself, they are very willing to engage with others who work in their realm of research.

Conference attendance allows for new collaborations and networking. Names can be put to faces, potential PhD supervision and postdoctoral opportunities identified and discussed. Collaborative projects can be kick-started.

The very purpose of conferences is of course to present new knowledge and new techniques. If you're doing science then you know already that you never stop learning. So the conference is a perfect place to help sate the thirst for such knowledge. A colleague once said "If I take home just one new idea from attending a conference it was worth going to." This should become a goal to fulfil.
Being given the opportunity of conference attendance allows one to display recent work, seek feedback on such work and identify collaborators or synergies with others. This is particularly the case where specialised sessions and workshops are held.

Of course it's not all about 'you'. With freedom comes the responsibility. Conference attendance is an investment by organisations in staff. Attending conferences allows staff to generate new skills, knowledge and networks, not necessarily all at the same conference of course. This can lead to scientific collaborations and synergies that science organisations need.

However, a sage advisor once said, "Before you collaborate with others have a beer with them."

## Letter to the Editor

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THE UNIVERSITY OF WAIKATO
*Te Whare Wānanga o Waikato*

21 November 2016

Dr David Houlbrooke,
Editor, NZ Soil News

Letter to the editor

National Policy Statement on Strategic Land Resources

I am writing to strongly support the two proposals made in *NZ Soil News* vol. 64 (3) (2016) by Paul Mudge in his editorial "Can we pull off a soils version of "The Dunedin Study"?, and by Peter Singleton in his letter advocating for a "National Policy Statement on Strategic Land Resources" that would include 'National Food Security Zones' of high class soil/land protected for exclusively soil based food production, along with national monitoring and reporting of the state of the soil resource. Paul's project looks timely and of national significance. Peter's proposal is just what we need and I think should become **the paramount concern of the incoming council of NZSSS**. I understand that the current council under president Reece Hill has made a number of submissions, which is good to hear. However, I think Peter's proposal demands a whole new level of engagement (by soil scientists around the country) with government representatives and parliamentarians, and others (such as planners and relevant staff in MPI and MFE) who have a genuine interest in soils and land use.

I would go so far as to say we can no longer stand back and take the development-biased outcomes dished out to us ad nauseam. Soils almost invariably come off second best under the RMA, as has been shown time after time in the courts, and so our high quality soils become even more precious and fragmented despite the section 5 mandate of the RMA. With our council leading the way at the behest of, and supported strongly by, the members of NZSSS, we stand a chance of turning the tide using Peter's suggested means. I am encouraged by a recent, first-rate article in the *NZ Listener* (19 Nov 2016) by Eloise Gibson, "Black gold: can soil save the climate?" because, finally, good writers in high-quality magazines are taking soils seriously rather than for granted, and writing articles of substance and in consultation with highly-qualified advocates (including Louis Schipper in the Gibson article; Stewart Ledgard appeared in another important article in the same issue).

At the same time the top policy and decision makers and practitioners are targeted, it may be timely to go to our schools again and perhaps council should consider purchasing copies of the new book "Celebrating Soils" by Megan Balks and Darlene Zabowski (ideally at a reduced rate) and donating them to every secondary school in the country (the Geoscience Society of NZ did this with the award-winning book "A Continent on the Move" first published in 2008). That is, we take both a 'top-down' and 'bottom-up' approach, which all those interested in taxonomy will appreciate!

Finally, it is great to see the Molloy and Christie book "Soils in the NZ Landscape 2nd ed" reprinted in paperback form. Good work, NZSSS council.

David J. Lowe
University of Waikato

## Obituary – Val Orchard

**Valerie Anne Orchard (PhD, Newcastle-Upon-Tyne) 1951 – 2016**

Soon after graduating with a PhD in microbial taxonomy from Newcastle University, Val Orchard emigrated to New Zealand in 1976 to take up a position at New Zealand Soil Bureau, DSIR, at Taita, Lower Hutt. Val brought a refreshingly no-nonsense approach to science and to life in general, which ruffled a few feathers among the hierarchy at Soil Bureau. However, she rapidly proved herself to be a hardworking, gifted scientist and an excellent colleague, willing to get involved, both professionally and socially.

Val developed a passion for soil microbial respiration and acquired a $CO_2$ – specific gas chromatograph to measure both soil basal respiration and microbial biomass C. In the late 1970s and early 80s, the Soil Biology and Biochemistry Team at Soil Bureau comprised scientists Des Ross, Kevin Tate, Gregor Yeates, Pauline McColl, Val and Tom Speir, later to be joined by Andy West and Graham Sparling. This very fertile group was involved in a great deal of cross-disciplinary research, including the highly productive Tussock Grasslands Climosequence study, which spanned a decade and produced over 40 scientific publications.

This interdisciplinary approach to soil research that this team pioneered had an unexpected, but marvellous spin-off for Val. She and a young soil physicist-cum-mathematician, Freeman Cook submitted a paper to the journal Soil Biology & Biochemistry entitled “Relationship between Soil Respiration and Soil Moisture”, published in 1983. This paper became one of the most cited publications in Soil Science internationally and was to be one of only 14 citation classics from the most prestigious soil science journal Soil Biology & Biochemistry from its inception in 1976 up to 2016, receiving to date around 650 citations.

At the same time, Val was thoroughly involved in ‘extra-mural’ activities both within the Soil Bureau and also the Soil Science Society. In these activities, Val was never just a joiner; she was a mover and a shaker when something needed moved or shaken. She was a co-editor of ‘Soil News’ for much of the 80’s, first with Jock Churchman and then with Lee Searle. She had a way with words and a social conscience, which could be seen in her editorials. She was passionate about this role to the extent of reporting on and promoting “Soil News” in a paper to the Society’s conference in 1984. She also served on the Society’s Council for a number of years, including as Vic-President. She was a well-deserved recipient of a Life Membership of the Society.

NZSSS Council 2000-2002

Val suffered from emphysema caused by alpha-1 antitrypsin deficiency, which at that time had been misdiagnosed as asthma, and this was to become a cause for concern when she had the opportunity to travel with a small Soil Bureau team to Antarctica in 1983. We were in the midst of making plans to go, when the results of her medical filtered through to DSIR Antarctic Division. She was told no – there is no way you can go, it's too risky. Well, anyone who knew Val well would know that that went down like a lead balloon. She was a real fighter and no way was she going to give up that opportunity! After much arguing the powers that be conceded that Val could join the rest of the team on the Antarctic Training Course at Tekapo Army Camp. This course – in mid-winter – is conducted under much worse conditions than prevail in summer time Antarctica, and involves on the final day a climb through thick snow up a pretty steep mountain alongside Round Dome ski-field – a total climb of around 800 m. Of course, Val was never going to make it up this mountain, so problem solved. The rest is history – Val got through with flying colours! She obviously made a really good impression on the course as nothing more was said about her eligibility to go south.

So in December, Val, armed with her trusty gas-chromatograph and hundreds of soil respiration tubes, headed off with Jan Heine, Hans Kohnlechner and Tom Speir to Cape Bird, Ross Island to study the decomposition of penguin guano. She loved Antarctica – the 10s of thousands of penguins, the seals, the scenery and the ability to get away from everyday humdrum. We all worked hard and long, but there was great camaraderie in our team and we found plenty of time for fun as well. Indeed, Val's Pam Ayers-like poetry skills are legend among that year's Antarctic teams.

Back in New Zealand, the next few years were fraught with change and stress: the highly critical DSIR Head Office review of Soil Bureau, followed by its demise in 1987, amalgamation with other DSIR institutes to form DSIR Land and Soil Sciences, then DSIR Land Resources, followed by the demise of DSIR and the establishment of the Crown Research Institutes. Val, along with a meagre group of ex-NZ Soil Bureau scientific staff joined Landcare Research in 1992. However, when Landcare chose to close the Taita campus in 1993 and relocate to Hamilton and Palmerston North, Val departed and joined The Consumer Institute.

In 1995 Val was appointed as Science and Research Manager at ESR, and tasked with growing ESR's small research base in an environment where there were strongly held beliefs, both within ESR and outside, that ESR should not be conducting any research at all –it is, and should remain, solely a service organisation providing analytical, scientific and consultancy services to key government clients such as the Police and the Ministry of Health. The view then was that even the small amount of research carried out was not ESR's business and should be done elsewhere. Val fought these views and prejudices so successfully, with her never give up attitude, that by the time she left the role in 2012, ESR had a very strong core of research underpinning its service delivery. Government-funded research had grown from about 2% of total ESR revenue to upwards of 20%.

Over this period, Val also spent 6 years on the Victoria University Council and was a member of the Environmental Risk Management Authority. All this when her health was deteriorating as a result of the emphysema arising from her alpha-1-antitrypsin deficiency.

Not content with taking life easy after ESR, Val set up her own consultancy business and has helped several institutes compile research bids and obtain research funding. She had plans to facilitate a meeting of researchers and end users in early November, and to the end was plotting from her hospital bed how she could do this.

I hope this has given you some insights into Val the scientist, Val the manager and Val the person. She faced life full on. She said she would never make old bones, and she sure as hell made certain every minute she had was crammed full of living. She loved and was loved by her family and her friends. Dr Valerie Anne Orchard is survived by her husband Jim and her three sons William, Jack and Jamie.

*Tom Speir*

Soil Bureau biochemisty group

Soil Bureau team

# Article :
# Tales of the unexpected: halloysite delivers surprises and a paradox

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## Introduction

Despite being first described nearly 200 years ago (Bethier, 1826; Joussein et al., 2005), halloysite still has the capacity to surprise. We report here the remarkable discovery in New Zealand of two new morphologies for this 1:1 Si:Al layered aluminosilicate member of the kaolin subgroup. One discovery was entirely serendipitous, thus lending validity to the famous phrase attributed to scientist Isaac Asimov (1920-1992) (Wainer and Lysen, 2009):

> *The most exciting phrase to hear in science, the one that heralds new discoveries, is not "Eureka" but "That's funny..."*

Moreover, the recognition of one of the new morphologies of halloysite helped enable a long-standing problem regarding the geotechnical property of sensitivity and its impact on landsliding in the Tauranga region, eastern North Island, to be solved. Such landsliding has commonly been attributed (possibly erroneously) to the dominance of nanocrystalline allophane, the clay commonly associated with halloysite in many weathered pyroclastic sequences and volcanogenic soils in North Island (Moon et al., 2015; Moon, 2016). In this article, we briefly summarise the circumstances and implications of the two discoveries relating to halloysite morphology, one published in *Clay Minerals* and the other in *Geology*, and a third study (also in *Clay Minerals*) relating in part to the formation of halloysite.
In doing so, we mark publication of a collection of 16 articles, and an editorial, on halloysite published in volume 51, issue 3, of the journal, *Clay Minerals* (Churchman et al., 2016a). In the editorial, entitled "The rise and rise of halloysite", Churchman et al. (2016b) have documented the remarkable actual and prospective uses of halloysite and show the exponential rise in numbers of papers relating to this clay since about 2005. Up until then, the main application of halloysites had been as an alternative raw material to kaolinite for the ceramics industry. In New Zealand, the main supplies derive from the Matauri Bay halloysite deposits in Northland, the world's dominant source (e.g. see Brathwaite et al., 2012; Walrond, 2016). But halloysite, especially its nanotubular form, has potential uses in nanocomposites with polymers, as carriers for active agents (e.g. in medicine, agriculture, and environmental remediation), and possibly for other medical uses in addition to drug delivery (e.g. in wound dressing and tissue engineering scaffolds), as anti-inflammatory agents, in water filtration, for the uptake of spilled oil, and various other promising applications (Churchman and Pasbakhsh, 2015; Churchman et al., 2016b).

## Discovery of halloysite in book form

Whilst examining clays in the weathered volcanogenic and tephra sequences, and paleosols, that underlie the landscape of the Tauranga region, masterate student at Waikato University, Justin Wyatt, using scanning electron microscopy (SEM) in 2008, came across what appeared to be classic 'kaolinite' book forms in samples from a somewhat-weathered tephra (dated at ~0.27 Ma) in a section at Tauriko

where a new subdivision was being developed (Figs. 1, 2). However, on analysis by X-ray diffraction (XRD), Justin found that the books seemed to be hydrated halloysite, not kaolinite. “That’s funny…”, he thought, because Justin, despite an exhaustive search of the literature, could find no mention of halloysite being reported in book form. Jock Churchman in Adelaide was contacted and he agreed with Justin’s conclusion that books invariably were seen to be kaolinite, and subsequently a short, preliminary paper was presented in 2010 at a meeting in Brisbane following the World Soil Congress in that city (Wyatt et al., 2010).


***Fig. 1.*** *SEM image showing multiple curved (vermicular) halloysite books of differing sizes in ~270,000 year-old Te Ranga tephra (Tauriko site, Tauranga). From Cunningham et al. (2016, p. 360).*

Waikato University colleague Vicki Moon, like Justin, was primarily interested in explaining the properties of the altered tephras and associated deposits with the view towards explaining pervasive and problematic landsliding in the Tauranga region, which seemed to be related to some layers that were very sensitive (Moon et al., 2013, 2015; Moon, 2016). Sensitivity is defined as the loss of strength (of earth material) upon remoulding, and is quantified as the ratio of undisturbed to remoulded undrained strength where both strengths are determined at the same moisture content. Values of <2 are insensitive, 4–8 are considered sensitive, 8–16 are extra sensitive, and >16 are referred to as ‘quick clays’ (Moon et al., 2015).

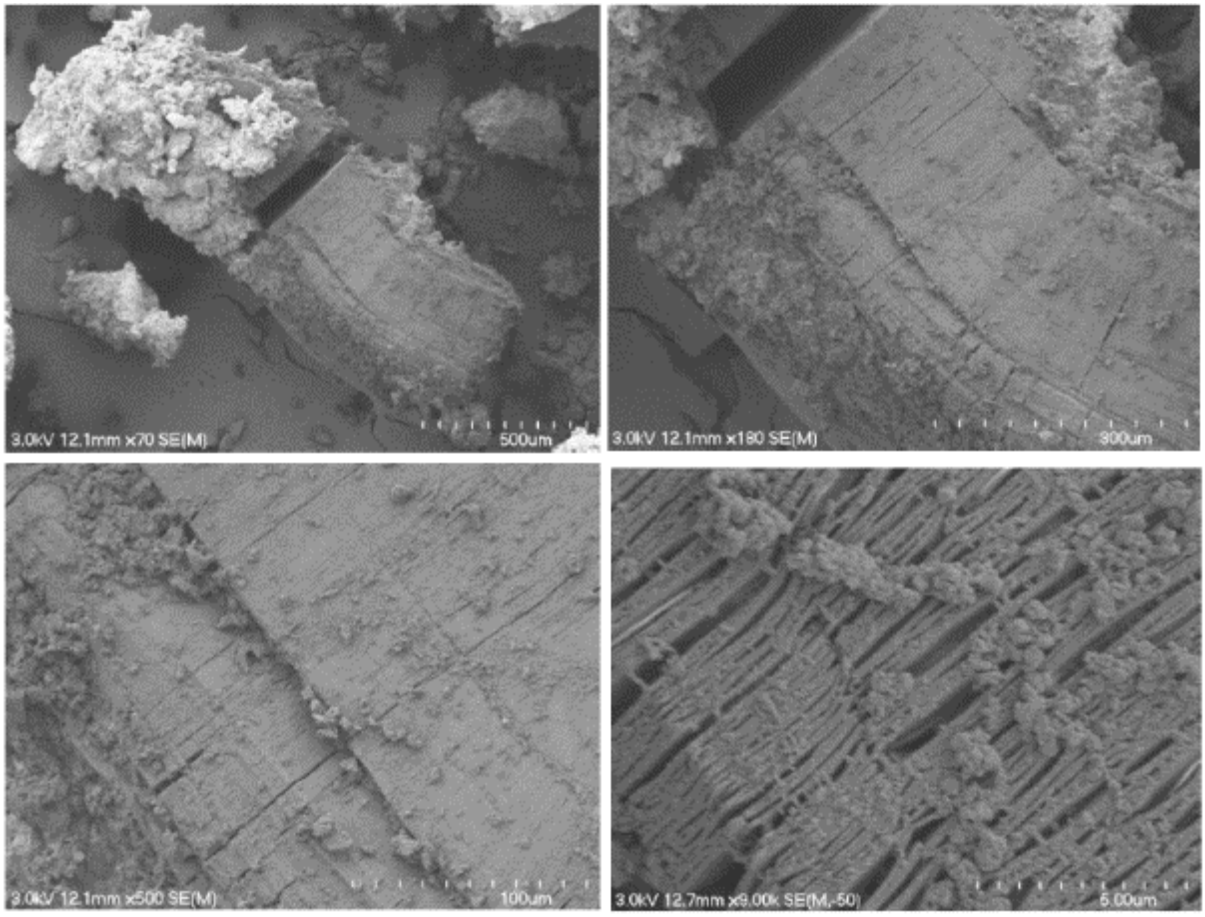


***Fig. 2****. SEM image of a giant, tightly laminated halloysite book (in two pieces) in ~930,000 year-old Te Puna tephra (Pahoia site, Tauranga). This book is ~1500 µm long (~1.5 mm). Enlargements of the book surface are shown, with increasing magnification, in images at top-right, bottom-left, and bottom-right. From Cunningham et al. (2016, p. 361).*

Vicki subsequently asked another masterate student at Waikato University, Michael Cunningham, to work on more sites around Tauranga Harbour. Occurrences of the book morphology were identified at two more locations and they were characterised in detail using XRD and other methods; all were shown to be halloysite, not kaolinite. In the resulting paper by Cunningham et al. (2016), the books were described as ~1.5 to ~1500 µm in length and they occurred in highly porous yet poorly permeable, altered, siliceous rhyolitic tephra deposits aged ~0.93 Ma (Te Puna tephra) or ~0.27 Ma (Te Ranga tephra) ~10 to 20 m stratigraphically below the modern landsurface. Unlike parallel studies elsewhere involving both halloysite and kaolinite (e.g. Papoulis et al., 2004), kaolinite has not formed in Tauranga presumably because the low permeability ensures that the sites largely remain locally wet so that the halloysite books are metastable.

An implication of the discovery therefore is that some halloysite books may have been misidentified previously as kaolinite on the basis of morphology alone (Cunningham et al., 2016).

**Discovery of halloysite mushroom-cap-shaped spheroids and a new attraction-detachment model that explains high sensitivity and proneness to landsliding in altered tephras**

In a detailed geotechnical study involving the INTERCOAST collaboration between Bremen University, Germany, and University of Waikato, Hamilton, the properties of the volcanogenic and tephra deposits and paleosols in a drill core associated with a coastal landslide (also referred to as a flow slide because of very long run out distances) at Bramley Drive, Omokoroa Peninsula, Tauranga, were examined (Fig. 3). A white, clayey silt layer, ~0.3 m thick, at 23 m depth in the core (also exposed in the scarp, e.g. Gulliver and Houghton, 1980) was identified as being highly sensitive (Smalley et al., 1980), and it had a very high concentration of spheroidal halloysite.

***Fig. 3**. Landslide at Bramley Drive, Omokoroa, photographed in October 1979, barely two months after the initial main failure event on 9 August that year. The landslide, ~60 m across, had a run out distance of at least 150 m from the base of the slope; the cliff edge receded by ~20 m, forcing the eventual removal of five houses in close proximity to the main scarp (Gulliver and Houghton, 1980; Moon, 2016). The slide was reactivated in May 2011 and in April and August 2012, causing further regression of the scarp. Photo: D.J. Lowe.*

Examining SEM micrographs of the spheroids before and after remoulding (kneading of samples by hand), PhD student at Bremen University, Max Kluger, noticed something odd about the before-and-after images. “Das ist merkwürdig…”, he mused. The spheroids seemed to look different depending on the remoulding. In the undisturbed state, they were distinctly aggregated into networks of well-connected particles but, after remoulding, most of the aggregates were broken apart into small, loose clusters or individual halloysite particles (Fig. 4). Max noticed that individual spheroids had distinctive “deformities” in the form of openings on one side and that these openings were previously hidden by contact with other spheroids. The deformities gave the particles an ovate “mushroom cap” appearance, and thus a new halloysite morphology, mushroom-cap-shaped (MCS) spheroids, was documented for the first time (Fig. 5). Point-counting individual spheroids in both undisturbed (aggregated) and remoulded (disaggregated) samples showed that the observable MCS spheroids increased around tenfold in abundance, from ~4 % to ~45%, respectively (Kluger et al., 2016).

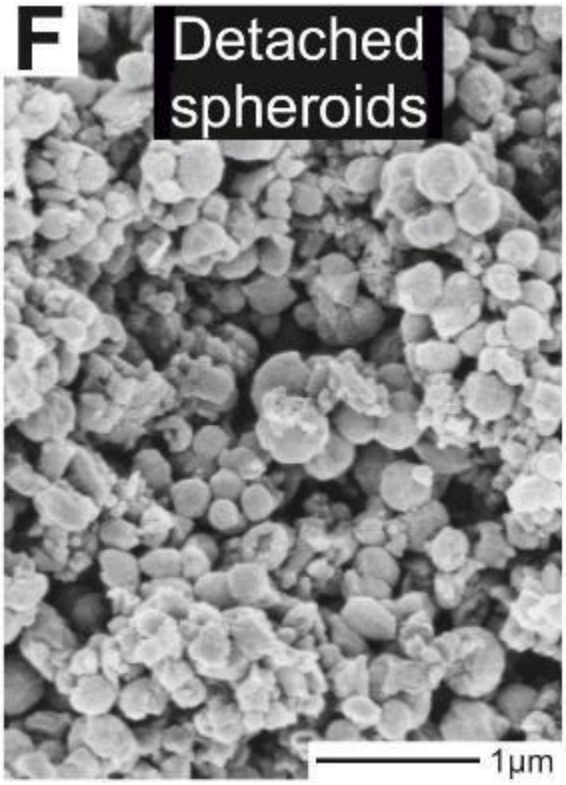


***Fig. 4.*** *SEM images of mainly detached or only weakly connected mushroom-cap-shaped halloysite spheroids after remoulding. These samples are from the sensitive layer that failed in the landsliding at Omokoroa (from Kluger et al., 2016).*

Because this particular morphology overwhelmingly occurred in the highly sensitive slide-prone layer, it was suggested that this unique particle shape controlled the mechanical behavior of the flow slide (Kluger et al., 2016). New work on the molecular-level structure of halloysite (Churchman et al., 2016c, reported below) has shown that at pH values between ~2 and ~8, the Al-octahedral (aluminol) sheet has a net positive charge and a Si-tetrahedral (silanol) sheet a net negative charge (see also charge density-functional modelling for halloysite nanotubes by Guimarães et al., 2010). The halloysite spheroids observed at Omokoroa are almost certainly composed of concentrically stacked 1:1 layers, i.e., with an onion-like structure, as shown in numerous studies (e.g. Wada et al., 1977; Kirkman, 1981; Berthonneau et al., 2015). Hence it was suggested that if sufficient numbers of positively charged openings are exposed, the electrostatic interactions between them and the negative exterior silanol surfaces would allow the MCS spheroids to form stacked aggregates. If the paired silanol and aluminol sheets exposed in the openings are neutral overall, then a net increase in particle attraction will still occur because electrostatic repulsion is reduced and the larger contact areas lead to higher van der Waals' forces (Kluger et al., 2016).

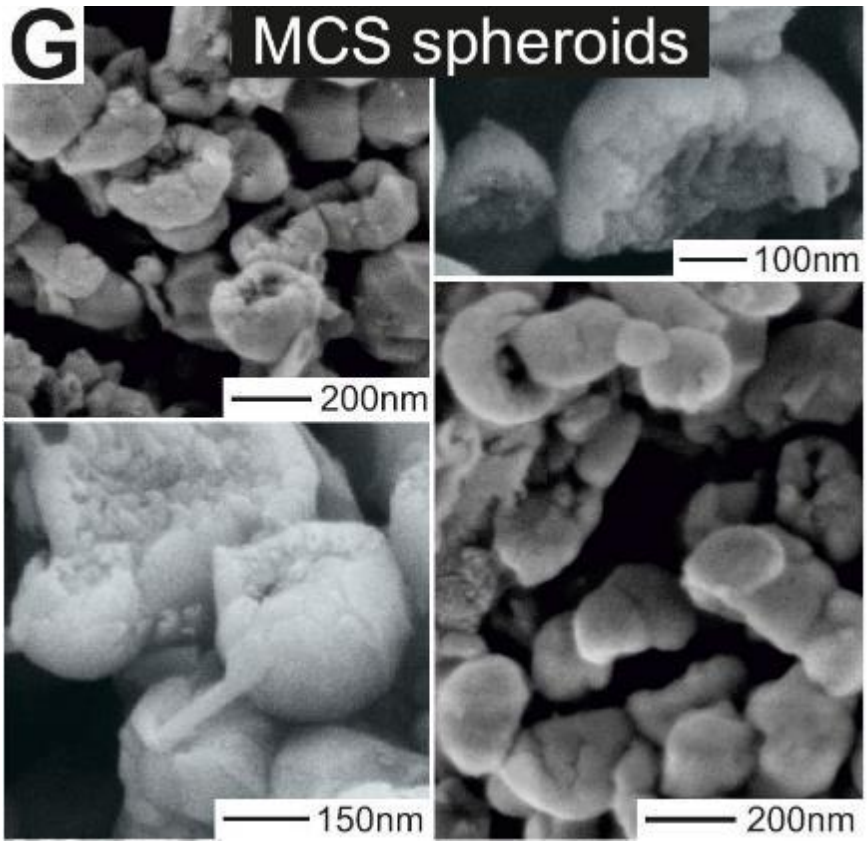


***Fig. 5.*** *SEM images of individual mushroom-cap-shaped halloysite spheroids with their distinctive openings on one side clearly visible (from the sensitive layer at Omokoroa) (from Kluger et al., 2016).*

Thus the landsliding took place at Omokoroa (and potentially elsewhere around Tauranga) because a layer dominated by MCS halloysite spheroids was highly sensitive. That high sensitivity in turn was explainable by the attraction-detachment model that relates to charge distributions on the MCS spheroids. The attractive forces between the openings (weakly positively charged or neutral) and the convex exterior surfaces (negatively charged) are demonstrably strong enough to allow for the formation of aggregates, but also permit easy disaggregation by mechanical detachment during shear, leading to flow sliding in the presence of abundant water (Kluger et al., 2016).

**How the lack of halloysite in basaltic ash-derived soils at Mounts Gambier and Schank in South Australia helped explain water intercalation in halloysite**

We studied the volcanic-ash soils formed at the mid-Holocene basaltic volcanoes of Mount Gambier and Mount Schank in southeast South Australia during David Lowe's sabbatical leave at CSIRO Soils Division, Adelaide, in 1991-1992 (e.g. Figs. 6, 7). Yet around 25 years later the soil mineralogy provided unexpected insight into halloysite's formation and molecular-scale structure, notably how different halloysites may employ a range of mechanisms for adsorbing and retaining interlayer $H_2O$, which is the defining feature of (hydrated) halloysite (Churchman and Carr, 1975; Churchman and Lowe, 2012). How interlayer $H_2O$ fitted into halloysite was a question that Jock had been pondering for nearly 50 years. Paradoxically, it was a *lack* of halloysite in the South Australian ash-derived soils that provided the key to answering it.

***Fig. 6*** *(**left**). Profile of soil (Humic Vitrixerand) mainly on basaltic ash at Brownes Lake near Mt Gambier, South Australia (marks on auger at 10-cm intervals) (from Churchman et al., 2016c, p. 400).*
***Fig. 7*** *(**right**). Profile of soil (Thaptic Haploxerand) on basaltic ash over a buried soil on aeolian sand at Laslett Road near Mt Schank, South Australia (knife ~25 cm long) (from Churchman et al., 2016c, p. 400)*

Apart from informing the identification of Andisols in Australia, a surprise in itself to most pedologists (Lowe and Palmer, 2005; Takesako et al., 2010; McDaniel et al., 2012), the clay mineralogy of the soils at Mounts Gambier and Schank seemed to conform to the New Zealand-developed Si-leaching model: the concentration of Si in the soil solution is controlled largely by the rate of leaching of the parent volcanic ash, its composition, and its drainage (Parfitt et al., 1983; Lowe, 1986; Singleton et al., 1989). A threshold of ~250 mm leaching marks the transition from conditions favouring halloysite formation to those favouring allophane. That is, >~250 mm throughput of leachate results in allophane, whereas ≤~200 mm gives rise to halloysite (Parfitt et al., 1984). In the soils at Mounts Gambier and Schank, under a xeric moisture regime and mesic temperature regime (Soil Survey Staff, 2014), the flow of water through the upper horizons is ~280 mm/year, typically for ~3–10 weeks during winter or early spring, similar to the upper threshold for halloysite formation in New Zealand. There is considerably less flow through the lower horizons in the South Australian soils, ~100 mm/year, which should favour halloysite formation (Churchman and Lowe, 2012).

However, XRD peaks near 7 Å for clays from many of the soil samples were observed but the basal spacing did not expand beyond ~7 Å when formamide was applied, indicating the absence of halloysite (Churchman et al., 2016c). “That’s funny…”, thought Jock and David: the conditions are apparently conducive to the formation of Al-rich allophane in upper horizons, but the limited leaching over the non-winter months seems to have favoured formation of Si-rich allophane (and phyllosilicate clays) instead of halloysite in lower horizons. The soils almost invariably contained kaolinite and illite, accompanied

sometimes by a smectitic phase, including interstratified kaolinite-smectite and/or illite-smectite, as well as allophane. Hence it seemed unlikely that Si concentrations were sufficiently low to limit halloysite synthesis (cf. Wilson et al., 2017). Furthermore, halloysite had been identified in soils on ash and volcanogenic materials under xeric moisture regimes in northern California (Takahashi et al., 1993). But the South Australian ash soils, with no halloysite, have high pH values (up to 8.7) whereas those from northern California have pH values of 5.3–6.9 (Churchman et al., 2016c). The high pH of the soils at Mounts Gambier and Schank is related to calcareous materials underlying both volcanic complexes, with the ash deposits and soils containing up to ~60% of exotic, non-volcanic materials, including xenolithic limestone fragments (Churchman and Lowe, 2012).

Churchman et al. (2016c) consequently proposed that pH plays a key role in the formation of halloysite, especially in the interlayer uptake of $H_2O$. The proposal is based on the difference in charge characteristics between the silica tetrahedral sheet and the alumina octahedral sheet. Various studies (including those of Vergaro et al., 2010; Abdullayev and Lvov, 2013, 2015) have shown that the two structural sheets have a different pattern of pH-dependent charge (as invoked, critically, by Kluger et al., 2016, in the Tauranga landsliding study noted above). The octahedral sheet is positively charged at all pH values below ~8, whereas the tetrahedral sheet is negatively charged at all pH values above ~2. It was therefore suggested by Churchman et al. (2016c) that the two sheets making up a layer of halloysite have opposite charges between pH ~2 and ~8. Consequently, the alumina sheet would attract the oxygen “end”, and the silica sheet the hydrogen “end”, of $H_2O$ molecules. This process generates a driving force for the uptake and retention of interlayer $H_2O$ by halloysite. Although kaolinite has the same sheet structure as halloysite to provide the same driving force, $H_2O$ molecules are not retained in the interlayer space of kaolinite because of the lack, or erratic supply, of water during its formation (Churchman et al., 2010; Gupta and Miller, 2010). This new hypothesis is consistent with observations that halloysites tend to occur in acidic environments.

An alternative (or additional) mechanism to explain why halloysite formation rarely occurs under alkaline conditions was also proposed following the work on the Mount Gambier and Mount Schank Andisols (Churchman and Lowe, 2014). It was argued that after its formation but prior to drying, halloysite contains ferrous ions in its octahedral sheet. The replacement of $Al^{3+}$ by $Fe^{2+}$ in this sheet raises the layer charge and cation exchange capacity. Ferrous ions are favoured over ferric ions under wet conditions but become unstable in relation to solid phases as pH rises. Ferrous ions, therefore, are rarely found in solutions of pH ≥ 6. The absence of halloysite in the ash-derived soils at Mounts Gambier and Schank may thus be linked to the requirement for ferrous ions during the formation of halloysite (Churchman et al., 2016c).

These two hypotheses replaced one put forward by Bailey (1990), who proposed that $H_2O$ was brought into the interlayers of halloysites together with hydrated cations in order to satisfy a small negative charge resulting from the replacement of Si (4+) by some Al (3+). However, using $^{27}$Al-NMR, Newman et al. (1990), also in New Zealand, found that halloysites had no more tetrahedral Al than kaolinites, contrary to Bailey’s hypothesis. Further, Bordallo et al. (2008), using quasi-elastic nuclear scattering, found that, unlike montmorillonite, halloysites had no cations in their interlayers. So everything but the kitchen sink has been thrown at the problem of the interlayer water in halloysite without a satisfactory explanation until now, we would claim.

## Conclusions

Firstly, always expect the unexpected: there is an infinite capacity to discovery in the sciences, including the geosciences, as illustrated by these three case studies. Secondly, could these advances and applications relating to halloysite, arguably now a 'supermineral' that is intimately associated with extensive volcanogenic deposits in North Island, together with new work relating to halloysite's 'ally', allophane (e.g. Huang et al., 2016a, 2016b; Taylor et al., 2016), herald a much-needed resurgence in clay mineralogy in the geosciences (including soil science) in New Zealand and elsewhere? We hope so.


## Acknowledgements

We thank colleagues and students who have contributed in many ways (from field to lab to write-up) to the exciting discoveries described here, and in other papers, relating to clay minerals and halloysite in particular. We especially thank the editors of the journals *Clay Minerals* and *Geology* for support, and editor of *NZ Soil News*, David Houlbrooke, who suggested we write this article.


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## Obituary – Ian Sweetman

I record the passing of **Ian Clifton Sweetman** in Hamilton (13 August 1924–14 November 2016). Ian was a soil science technician who designed and made soil-testing equipment for agriculture whilst initially based at the Galloway Laboratories in Dey St, Hamilton, from the late 1940s-early 1950s onwards for many years. He was thus central to many soil science-based research activities of the Ruakura and Rukuhia research stations of the Department of Agriculture when equipment often could not simply be purchased from a catalogue: it had to designed and made.

Ian developed a parallel, second career as a luthier, making around 130 violins and violas to an internationally-recognised standard, and is regarded as the 'father' of stringed instrument making in New Zealand. Also a violinist himself, Ian won a QE II Arts Council Grant to study violin/viola making overseas for ~9 months in 1968. His instruments are played all around the world and in New Zealand. One of Ian's sons, Noel, became a luthier, and Noel's son, Mark, continues the tradition.

*David Lowe*

## Article

**MEMORIES OF SINGAPORE 1974 – N.WELLS**

**INTO MALAYSIA WITH THE N.Z. ARMY**

While living with the New Zealand Army in Dieppe Barracks, once a British base and conveniently opposite where I was working at the Agricultural Research Station near Sembawang in Singapore, I had been invited to join their social activities. This was usually a film show, but one event stood out.

A visit was proposed to the nearest Malaysian Army Base at Muar, south-east of Malacca. It was not a popular way for the soldiers to spend Saturday off; they preferred going into central Singapore, Malaysia being generally considered not much fun. The NZ Army bus was only half full, and since the cost of the petrol was shared out amongst those going, I agreed to help out by joining them. I asked about my passport, and Malaysian money, and was not totally reassured by the airy reply that the N.Z. Army does not use passports, and we could get lunch in their Army Mess. However, I was dressed for the part in khaki battledress, though with no insignia of country or rank. So into one pocket in my battledress went my passport, and into the others three sorts of currency, Singapore, Malaysian and a backup of US dollars. Taking a camera was dismissed as too risky; a civilian in battledress pointing a camera out of a bus in another country's military base could be spying.

The visit was organised by the Social Club, but since a senior officer was included I suspected he might have influenced the choice. I ventured to ask what arrangements had been made with the Malaysian military, but all I could get was an inference from the statement that Malaysian soldiers would always be welcomed at Dieppe Barracks, and given a meal in our Mess.

The Causeway to Malaysia was only a short drive from the Barracks. Our Social Club organiser, with a list of names in his hand, and the senior officer, with swagger stick under his arm, went into the border control post on the Malaysian side, and did not emerge for what seemed a long time. They came out, we were passed through; I still had my doubts about not presenting my passport.

There followed a long drive past rice padi up the west coast, way off the main road from Johore to Kuala Lumpur. The soldiers in the bus debated which Army Mess would have the best food, ending with total agreement that it had to be the Sergeants'. We arrived at the Gate House of the Malaysian Barracks, and the process was repeated; our two delegates again negotiated entry for the bus. They quickly emerged and joined us in the bus, the pole across the roadway was raised, and we drove in. Our soldiers laughed, rolling around in their seats, the social club organiser kept a straight face, the senior officer had a slightly smug look of "I told you so", and I wished I had brought my camera. The former British Base had morphed into a Malaysian kampong (village). The huts that had housed troops of soldiers had become family units, with flowers growing around the doorways, and small gardens attached. Children ran around and played between the huts. We drove around, looking for an army; we did not find it, and we did not find lunch. The visit quickly ended, we exited the base via the gate (apparently just to keep the locals out) and proceeded back towards Singapore.

But an army marches on its stomach, and our soldiers had hunger pangs. We made an unplanned stop at a roadside eating house, and all trooped in. The senior officer ordered us all to empty our pockets of cash on to the table. A small pile of Singapore coins built up under the eye of the tour organiser. I was last in line, with a whole bank of three currencies, so I emptied out just one pocket and camouflaged the coin pyramid with fairly low value Malaysian bank notes. The Social Club organiser allowed himself just a tiny smile. The owner of the café came with a bucket, scraped up our contributions, and without trying to count it, said "Rice, meat, sauce, fizzy drink. No beer".

During the drive back to Singapore a small delegation of soldiers spoke to the tour organiser, who then spoke to the senior officer, who in turn spoke to the driver, who shook his head – No, there were no toilets en route. Well, it was a minor road, so we pulled up by the side of the usual monsoon drain. All were ordered to line up, shoulder to shoulder alongside of the ditch. I was at the far end of the line from the officer, as he gave the command. I cannot be sure if he joined the ranks for the exercise. A very relieved army was dismissed back to the bus. We soon made another stop, to give our driver a break, at the ceramic factory shop near Ayer Hitam (where there was a public toilet). We looked at the pots on sale, of heavily glazed thick earthenware, indicating poor pottery clay. They did not hold much interest for the Army, unsuitable even for target practice, because of the danger from ricocheting bullets.

As our Army bus headed back along the main road to Singapore I thought back to the Japanese Army coming the same way early in 1942. Among these were bicycle infantry, capable of some off-road manoeuvres. Troops as mobile as these would be helped by detailed knowledge of the terrain, an Army Going Map. I asked myself whether the units of a soil map could be interpreted to express the ease, or difficulty, of manoeuvring vehicles off-road, especially heavy wheeled ones. The underlying soil physics, changes in soil strength under shear stress, would require soil descriptions redesigned in terms of vehicle traction. In any case, the Soil Map of Malaysia would not be available for another two years, making the idea even more difficult.

In the humid tropics water and vegetation limit vehicle movement when off-road. Extreme difficulty could be anticipated when meeting mangrove forest growing on saline gley soils. Another problem would be met in rice padi on alluvial soils; these could be flooded to reduce weeds, and flooded again in the monsoon. Jungle also is a challenge for wheeled vehicles, except in plantation agriculture such as rubber or oil palm, where patches of land are modified to allow the crop to be moved out. Organic soils and the very deep forest peats act as reservoirs for the river systems, and are no place for wheeled vehicles. Slope categories of the land surface would be another factor that could be added to the map as hatching. It became obvious that in Malaysia, land use units could be a simpler basis for a “Going Map” than soil units.

In soils of the humid tropics clay minerals are the result of intensive weathering processes, usually strengthened by aggregation with iron. The highest soil strengths were undoubtedly in the iron-rich lateritic soils derived from ultra-basic rocks inland from Malacca. These could be rated as Army-Proof.
In temperate regions of the world, however, clay minerals at an intermediate stage of weathering may have an interaction with water that can change under shear stress. In the Darling Downs region of S.E. Queensland, farmers on their black vertosol, with montmorillonitic clays derived from basalt, left their cars on the verge of the sealed road and walked home after a shower of rain, road gravel being not available for farm tracks in that huge area. Good examples of sensitivity to shear stress are found in New Zealand. The non-crystalline clay allophane, developed from andesitic volcanic ash, when used as farm tracks without gravel, developed a U-shaped cross-section, resulting from the snake-like movement as vehicles manoeuvred. On the Volcanic Plateau tracks crossing from one small terrace to another offered three choices; straight ahead was chopped up beyond use for 2-wheel drive, so one side offered a downhill slide, while on the other side an uphill route gained traction over dwarf vegetation. For temperate regions, soil units could have an advantage over land use units for an Army Going Map.

Still pondering about Going Maps, as the Army bus approached the border on our return trip, I asked myself what sort of army would need such a map. It would be for attack, rather than defence, so certainly not our N.Z. peace-keeping contingent. The N.Z. Army was in Singapore to provide stability while the differing countries of the ASEAN group worked out how to live adjacent to one another. The disestablishment of the nearest Malaysian Army Base to Singapore, and its transformation into

domesticity that we had seen that day, indicated that in this region these two countries had learnt to live as close neighbours.

Our bus slowed down to pass through the Malaysian exit control post, where the guards gave us a friendly wave through to the Causeway. On the other side the Singapore entry guards passed us through with a friendly salute; I just patted the pocket with my passport. Outside our Barracks gate a few taxis were in wait for anyone wanting a belated Saturday evening in town. Night descends fast near the Equator. Nobody about, bar closed, but tied to its refrigerator handle was an IOU book. Have a very cold beer!

POSTSCRIPT, 42 years later

As I grew up in England, my first real contact with maps outside geography lessons was the OS series of topographic maps, using them to plan walking routes between Youth Hostels, and learning to read them to visualise the landscape, in particular to avoid bogs. I did not know that before becoming established as general purpose maps they had an old history as Army Going Maps, the origin of the name Ordnance Survey. After the failed Jacobite rebellions to restore the Stuart dynasty, in 1715 and 1745, the English Army set about unifying Britain by a military assault on their stronghold, the Scottish Highlands, from around 1750. Army equipment, notably the heavy ordnance of wheeled cannons, tended to bog down on the way to engagements. The Ordnance Survey was to give guidance as to what terrain could be expected during army manoeuvres.

The N.Z. Army Battalion pulled out of Dieppe Barracks in Singapore and returned to New Zealand in 1989, the peace-keeping mission fulfilled.

*N Wells*

# IUSS – Contributions from Bulletin 129

**CONSOWA 2017 – Request for contributions to Session 2, dedicated to the International Decade of Soils (2015-2024)**

During CONSOWA 2017, Discussion Session 2, dedicated to and sponsored by the International Decade of Soils (2015-2024) proclaimed by IUSS, will focus on analysis and setting the challenges and required achievements in the next decade, to prevent and counteract the previewed effects of global changes on soil and water degradation processes, and effects on food and water supply for the increasing World population, on the environmental degradation and on natural disasters.

Potential authors are kindly requested to submit their contributions, namely about two pages each (present situation, and recommendations for the future) with their ideas before 31 January 2017 to Ildefons Pla Sentis at ipla@macs.udl.cat . A draft document, including the different proposals, will be sent for further corrections to all contributors and reproduced to be distributed before the Conference, as a document for discussion. Contributions will be included in the final document to be published as part of the conclusions and recommendations of CONSOWA2017.

**ICSU and ISSC to merge into a new international science council**

"The world faces great challenges and society increasingly looks towards science to address them. This places demands on all fields of science in all parts of the world. It compels a global response, involving strengthened collaboration within the international scientific community and between it and the world of policy and business, civil society, and the public at large", the Presidents of the ICSU and the International Social Science Council (ISSC) stated in a joint letter. The ICSU Executive Board and the ISSC Executive Committee therefore decided to consult their members on the possibility of merging the two Councils. Thus, an extraordinary ICSU General Assembly was held in Oslo, Norway, on 24 October 2016 jointly with the ISSC. IUSS was represented by Takashi Kosaki. The decision of the joint Assembly was to approve the merger in principle and to allow the two Councils to develop a strategic and transition plans for setting up a new international science council. Despite a reportedly significant number of ICSU unions being against the merger, 76% of ICSU Members and 87% of ISSC Members voted in favour of a future merger of the two organizations. The final decision on the merger will be taken by the membership of ICSU and ISSC at the ordinary General Assembly of ICSU in October 2017.
Read more: http://www.icsu.org/news-centre/news/top-news/world2019s-top-bodies-representing-the-social-and-natural-sciences-vote-to-pursue-a-merger-forming-a-single-organization-representing-all-social-and-natural-sciences-by-2018

**Wind Erosion Quantitative Assessment**

A GIS version of the Revised Wind Erosion Equation (RWEQ) was developed in JRC to model wind erosion at large scale. The RWEQ was developed to i) move a step forward into the large-scale wind erosion modelling, ii) evaluate the soil loss potential due to wind erosion in the arable land of the EU, and iii) provide a tool useful to support field-based observations of wind erosion. The model was designed to predict the daily soil loss potential at a ca. 1 km2 spatial resolution. The average annual soil loss predicted by GIS-RWEQ in the EU arable land totalled 0.53 Mg ha-1 yr-1. Cross-validation shows a high consistency with local measurements reported in literature. The Revised Wind Erosion Equation (RWEQ) quantitative asse ssment (2001-2010) is available for download (together with the relevant datasets on Wind-erodible fraction) and Index of Land Susceptibility to wind erosion).
Read more: http://esdac.jrc.ec.europa.eu/content/Soil_erosion_by_wind

**Sampling depth confounds soil acidification outcomes**

Low soil pH can affect herbicide persistence, decrease nutrient availability, and contribute to metal toxicity, all of which can compromise crop production. In the Northern Great Plains (NGP) of North America, surface sampling depths of 0 to 15 or 0 to 20 cm are suggested for testing soil pH. Soil acidification, however, is often most pronounced nearer to the soil surface. In a new article published in the Soil Science Society of America Journal, researchers at the USDA-ARS Northern Great Plains Research Laboratory quantified soil pH change in two long-term dryland cropping studies near Mandan, ND. Soils were sampled at multiple depths in both studies, allowing for soil pH evaluation at surface (0–7.6 cm) as well as deeper (0–15.2 and 0–30.5 cm) depths.

Read more: https://dl.sciencesocieties.org/publications/sssaj/abstracts/80/5/1424

**Meet NASA's robot destined to mine Martian soil**

It looks like the Curiosity rover won't be the only craft exploring Mars. NASA recently released a video of its latest Regolith Advanced Surface Systems Operations Robot prototype going through its paces in a test facility. "RASSOR uses counterrotating bucket drums on opposing arms to provide near-zero horizontal and minimal vertical net reaction force so that excavation is not reliant on the traction or weight of the mobility system to provide a reaction force to counteract the excavation force in low-gravity environments," NASA writes.

Read more: https://www.engadget.com/2016/10/03/meet-nasas-robot-destined-to-mine-martian-soil/

**The woman who digs the dirt to catch serial killers**

Forensic soil scientist Prof Lorna Dawson is helping detectives solve decades-old murder cases.

Read more: http://www.bbc.com/news/uk-scotland-37561722

**Prince Charles joins clean soil project to combat climate change**

Prince Charles urged governments, individuals and businesses to take greater care of the world's soils as part of an initiative aimed at keeping carbon locked in soil, rather than escaping into the atmosphere and causing global warming. The "4 per 1000" project is a pledge to reduce the amount of carbon leaked from soils by 0.4% a year, which would be enough to halt the rise of carbon dioxide levels in the air. Nearly 180 countries have signed up to the initiative that was set up by the French government as part of its efforts to make the Paris agreement on climate change, signed last year, a success.

At a ceremony this week to celebrate the initiative, the prince said that the preservation of farmland, forests and soils were of "absolutely critical importance – for, in my experience, the fertility and health of the soil is at the heart of everything". Drawing on his own work as an organic farmer, he contrasted organic methods with the "previously conventional" farming systems which he called "toxic". The 4 per 1000 initiative does not require farmers to adopt organic methods, but does encourage more attention to farming techniques, which are currently contributing to the erosion of soils around the world. The prince said this project could "make a remarkable contribution to the wellbeing, livelihoods, food security and resilience of farmers, to the health of the planet and to addressing climate change".

Read more: https://www.theguardian.com/environment/2016/oct/28/prince-charles-joins-clean-soil-project-to-combat-climate-change

# European Soil Data Centre Contributions

**Wind Erosion quantitative assessment**

A GIS version of the Revised Wind Erosion Equation (RWEQ) was developed in JRC to model wind erosion at large scale. The RWEQ was developed to i) move a step forward into the large-scale wind erosion modelling, ii) evaluate the soil loss potential due to wind erosion in the arable land of the EU, and iii) provide a tool useful to support field-based observations of wind erosion. The model was designed to predict the daily soil loss potential at a ca. 1 $km^2$ spatial resolution. The average annual soil loss predicted by GIS-RWEQ in the EU arable land totalled 0.53 Mg $ha^{-1}$ $yr^{-1}$ . Cross-validation shows a high consistency with local measurements reported in literature. The Revised Wind Erosion Equation (RWEQ) quantitative assessment (2001-2010) is available for download (together with the relevant datasets on Wind-erodible fraction) and Index of Land Susceptibility to wind erosion):

http://esdac.jrc.ec.europa.eu/content/Soil_erosion_by_wind

**Trainee in soil contamination plus other soil-related vacancies**

The Land Resources Unit is looking for a highly motivated trainee to support its work in reviewing the existing soil policy tools and methodology used in EU Member States to restore contaminated soils. This activity builds on the information made available in a Wiki platform with input from EU member countries. The objective of the project is to contribute to achieve that "by 2020 land is managed sustainably in the Union, soil is adequately protected and the remediation of contaminated sites is well underway" as stated in the 7th Environment Action Programme. Application **deadline**: 14/11/2016— Location: Ispra, Italy

More vacancies announced in ESDAC: http://esdac.jrc.ec.europa.eu/vacancies

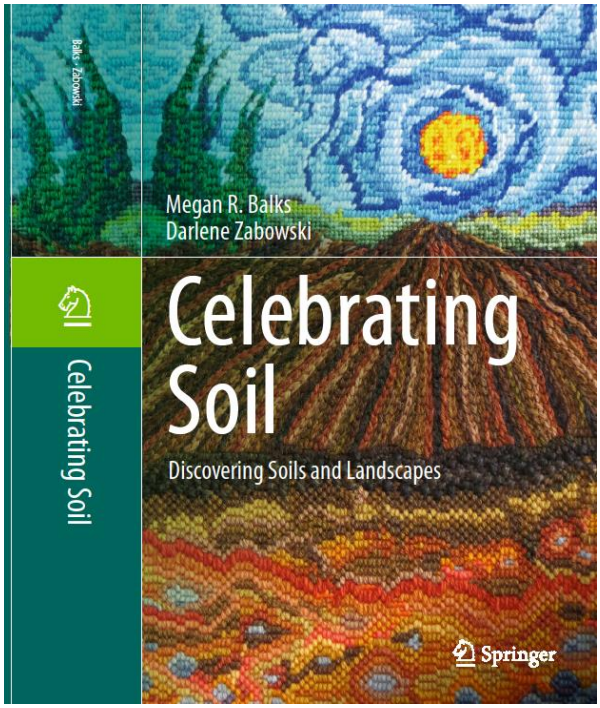
**Soil Erosion modelling workshop**, Ispra (Italy) 20-22 March 2017

This workshop will discuss mainly issues how the local and regional modeling results can be upscaled (or applied) at European scale. The workshop will try to focus on how various project or local/regional modelling applications can improve the “know-how” at European scale. Scientists dealing at small scale are invited to present the possibilities and limitations of upscaling their results. Scientists operating at large scale should think how to validate their modelling/ mapping with small scale data. Emphasis will also be given to management practices that can reduce soil erosion. Workshop financial support includes accommodation, transfer from/to the airport, transfer between JRC and hotel, lunch/coffee, etc. Details on the logistics and the proposed agenda are in the page:

http://esdac.jrc.ec.europa.eu/themes/erosion-modelling-workshop

## Publication:

**New Book: Celebrating soil: discovering soils and landscapes** by Megan Balks and Darlene Zabowski. Springer publishers.
http://www.springer.com/gp/book/9783319326825




This richly illustrated book, written for a general audience, celebrates the diversity, importance, and intrinsic beauty of soils around the world. It helps the reader to understand the ways that soils are related to the landscapes in which they form. The book unravels the complex bond between humans and soils and the importance of soils in our cultures and everyday lives.

Soil is critical to terrestrial life on earth. It underpins human food supply and provides materials on which we build our lives. Soil is out of sight and often out of mind, thus easy to overlook. Yet soil has tremendous variety and intrinsic beauty for those who care to look. Soil contains a memory of the events that have shaped the landscape and the environment. With help you can look at a soil and understand the stories that it has to tell.

*About the authors*

Dr Megan Balks has over 30 years of experience in soil-related study, research, and teaching. Megan is based in New Zealand (at the University of Waikato), and her experience includes 19 trips to study soils in Antarctica as well as work throughout New Zealand. Megan has also travelled widely to study soils having undertaken fieldtrips in many parts of the world, including the Arctic (Russia, Norway, and Alaska), Australia, Thailand, Peru, China, Samoa, and Europe. Megan undertook her PhD studying irrigation of effluent onto land, and she has also worked on water irrigation schemes in Otago and effluent irrigation in Australia. She has supervised over 40 graduate thesis projects on the widest range of soil-related studies from soil fertility in New Zealand hill country, through irrigation of city wastewater onto land and study of some of the most southerly soils on the planet in Antarctica. Megan is a fellow of the New Zealand Society of Soil Science. With her husband Errol, Megan owns a small hill country sheep farm, which also includes about 60 acres of New Zealand native forest, and so she has hands-on experience in managing the land.

Professor Darlene Zabowski has a BS in forest ecology and an MS and PhD in soil science. She worked as a research soil scientist for the US Forest Service before transferring to the University of Washington in 1993. She has conducted research on soils and taught introductory soils and advanced classes in soil science for 30 years. She has received several awards for excellence in teaching. Darlene has worked with many soils in various areas of the USA, as well as Canada, New Zealand, and China, and participated in field trips in many other parts of the world. Her research has mostly focused on forest soils but has often included comparative research with soils from other ecosystems and a variety of landscapes. Darlene is an avid hiker and enjoys keeping the soil in her vegetable garden healthy.

The book is being launched on World Soils Day, Monday 5 December at Waikato Museum (4.00-5.30 pm), Hamilton, alongside a new soil-related exhibition on sustainable dairying.

# News from the Regions

## Waikato/Bay of Plenty

### Waikato University

**Louis Schipper** visited **Ian Layden** (Department of Agriculture, Fisheries and Forestry) and Peter Grace (QUT) in Brisbane. There is increasing interest in use of denitrifying bioreactors in Queensland particularly in agricultural land where they grow pineapples and sugar cane. Ian has installed a bioreactor into the base of a stream and just getting started on making measurements of nitrate removal. He and colleagues are considering building additional bioreactors and should be the start of a strong cross-Tasman collaboration. **Jamie Millar** has started an MSc project with Louis Schipper and **Paul Mudge** on the impact of irrigation on soil carbon and nitrogen stocks following on from their recent finding of lowered stocks under irrigation. **Jasmine Robinson** has started a PhD examining the stability of newly incorporated organic matter after exposure to stressors, also supervised by Louis. **Katharyn Duffy,** a PhD student from Northern Arizona State University, is also visiting Louis to apply macro-molecular rate theory to the temperature response of a global dataset of ecosystems carbon dioxide exchange.

**Megan Balks** and **Darlene Zabowski** (University of Washington) have published a book "Celebrating Soil – Discovering Soils and Landscapes" (Springer). This book, a major achievement, is a cross between a lavishly illustrated coffee-table book and an introductory text about soils from a global perspective. Further information about the book, and a link to the publishers, is provided elsewhere in this issue. Please check out the book and buy a copy – you will not be disappointed!

**David Lowe**, although on leave until the end of the year, has been busy with a project funded by EQC and the Waikato Regional Council to study cryptotephras ("hidden" glass shard and/or crystal concentrations in sediments or soils insufficiently numerous to be visible as a layer) preserved in lake sediments in the central Waikato area (Fig. 1) to develop a better record of volcanic ash-fall in the region and thus to improve volcanic hazard modelling. The project involves collaboration with GNS Science and Victoria University of Wellington along with staff at several other universities in Australia, Germany, and the UK. **Remedy Loame**, a new PhD student, is working on the cryptotephras. At the time of writing, Remedy is at Swansea University in south Wales, UK, where **Siwan Davies** and others are helping her with glass-shard extraction techniques.

*Fig. 1. Extracting a core of sediment from Lake Kainui in September. Doing the hard yards are Marcus Vandergoes (left, GNS Science) and Andrew Rees (Victoria Univ. of Wellington). Photo: D.J. Lowe.*

As well as cryptotephras, the lake sediments are revealing liquefaction features of some (but not all) tephra layers that are thought to reflect shaking from earthquakes, with the liquefied tephras being referred to therefore as 'tephra seismites'. The seismites show (a) ash-filled cracks or fractures beneath the tephra (with sharp terminations); (b) funnels and voids, some infilled with lake sediment, within the tephra; (c) disrupted bedding or dislocated tephra layers; and (d) wavy to convolute contacts at tephra

boundaries. Tephra layers, denser than the organic lake sediments, do not seem to become buoyant as occurs in terrestrial settings on liquefaction but instead are injected downwards into distinct cracks to dissipate pore water pressure.

A range of evidence has indicated that there are multiple hidden faults in the Hamilton area (first reported in the media last year) and so David, Remedy and others, including engineering geologist **Vicki Moon** at Waikato, and **Max Kluger** (PhD student) and **Tobias Mörz** at Bremen University in Germany, are attempting to replicate the features using laboratory experiments . David is also applying CT scanning to the lake sediment cores at the Hamilton Radiology clinic with **Nic Ross** (supported by **Philip Hassall**) generating very interesting images (Figs 2-3). Similarly, **Richard Johnston** at Swansea University (Bay Campus), with help from Remedy, is using micro-CT scanning to examine liquefied tephras . The work on the tephra seismites is funded in part by a grant from the strategic investment fund (SIF) of Waikato University.

*Fig. 2. Core being prepared for CT scanning by Nic Ross (Hamilton Radiology). Photo: D.J. Lowe.*

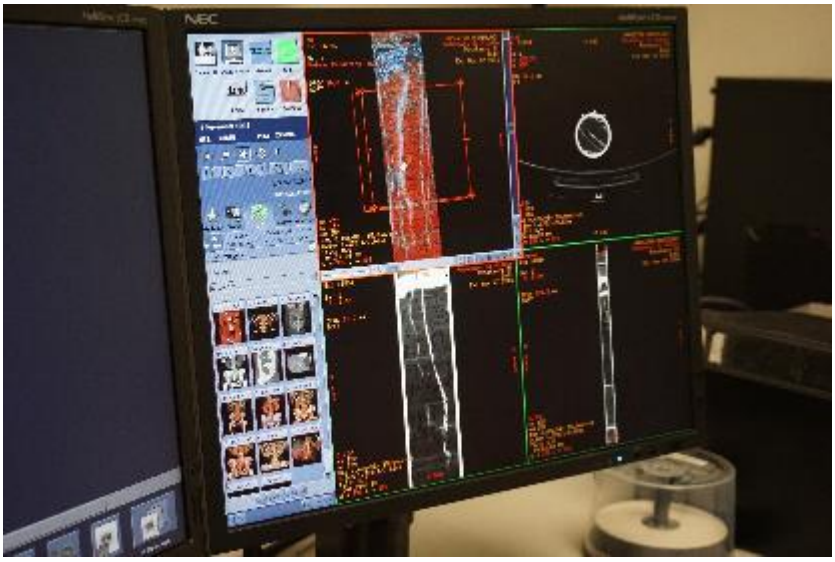



*Fig. 3. Spectacular images of CT scans of lake sediment, Lake Rotokauri. Tephra layers are readily evident in X-radiograph at bottom right. Photo: D.J. Lowe.*

**Sharn Hainsworth** has begun a part-time thesis at Waikato with **David Lowe** (chief supervisor) and **David Palmer** (formerly Landcare Research), **Alan Palmer** (Massey University), and **Louis Schipper**. Sharn's project is entitled "Optimising digital soil mapping techniques in the hill country of Hawkes Bay, New Zealand, using classical and geostatistical soil mapping techniques".

Another fruitful area of research has been the serendipitous discovery of not one but two new morphologies of the clay mineral halloysite, and the development of a new attraction-detachment model to explain sensitivity and landsliding in clay-rich tephras in theTauranga region. Older readers may recall the landsliding that occurred in the area way back in 1979, and the Omokoroa landslide in particular (Fig. 4). Finally, more than 38 years later, a satisfactory explanation for the slide has been published in the journal "Geology" (see abstract by **Max Kluger** et al. in this issue). This work, and the other remarkable discoveries about halloysite, fast becoming what might be called a 'superclay' because of its nanoscale properties, are written up elsewhere in this issue by **David Lowe** and **Jock Churchman**.

*Fig. 4. Looking down the slip face at Bramley Drive, Omokoroa, Tauranga Harbour (Dec 2014). The landsliding occurred in 1979 with two minor reactivations in 2011 and 2012. Photo: D.J. Lowe.*

In terms of conferences, a number of staff including **Beth Fox, Willem de Lange, Vicki Moon, Shaun Barker,** and **David Lowe**, attended and participated in a one-day workshop on the Hauraki Rift organised by **Jennifer Eccles** at Auckland University on 17 October. Following on from this, late November and early to mid-December are shaping up as important weeks for a number of the staff in the Earth sciences group at Waikato. Briefly, **Megan Balks** and **Louis Schipper** are taking **9 students** to the ANZ soils conference in Queenstown, which promises to be an excellent meeting; **Adrian Pittari, Shaun Barker, Cam Nelson** and **7 students** are attending the annual Geoscience Society of New Zealand conference in neighbouring Wanaka; and **Alan Hogg, Adam Hartland, David Lowe** and **5 students** are participating in the Australasian Quaternary Association (AQUA) biennial meeting in Old Government House, University of Auckland. The AQUA meeting is only the third to be held in New Zealand since the organisation was formed around 34 years ago. The level of participation has exceeded expectations markedly, attesting to the good work by convenor **Drew Lorrey** (NIWA) and his team.

The AQUA conference (5-9 December) will be followed by a field trip to Northland where swamp kauri and other Quaternary treasures will be visited (Fig. 5). The swamp kauri deposits have been in the news lately because of the alarming volumes of such kauri, a unique archive, being exported. To quote the MPI website:

"In response to public requests, the **Auditor-General** completed, on 10 September 2015, an investigation into ancient swamp kauri management under the Forests Act by the Ministry for Primary Industries (MPI). The Auditor-General concludes there is no evidence that MPI is allowing the export of illegal timber or timber products. The Auditor-General has made 4 suggestions to improve oversight and management of swamp kauri resources under the Forests Act. MPI is progressing those suggestions."

*Fig. 5. Extracting an ancient kauri log from peat in Northland. Photo: J.G. Palmer.*

However, despite this ruling, NIWA is currently running an online survey about the value of swamp kauri: to participate, please see http://extent.com.au/swamp-kauri-survey/

Finally, we warmly congratulate geochemist Adam Hartland, who has been awarded a Rutherford Discovery Fellowship (the first to be awarded to a Waikato University staff member) comprising $800,000 over five years for his project "Unlocking the karst record: quantitative proxies of past climates from speleothems" (Fig. 6). Adam's study addresses the need to find new ways of working out the exact range of past rainfall and air temperature variations over the recent geological past (up to the last 10,000 years).

*Fig.6. Adam Hartland working in a cave. Photo: supplied.*

**Megan Balks** and **Darlene Zabowski** (University of Washington) have published a book "Celebrating Soil – Discovering Soils and Landscapes" (Springer). This book, a major achievement, is a cross between a lavishly illustrated coffee-table book and an introductory text about soils from a global perspective. Further information about the book, and a link to the publishers, is provided elsewhere in this issue. Please check out the book and buy a copy – you will not be disappointed! The book is being launched on World Soils Day, Monday 5 December at Waikato Museum (4.00-5.30 pm), Hamilton, alongside a new soil-related exhibition on sustainable dairying.

## Lincoln Agritech

**Vision Mātauranga project with Kāi Tahu ki Otago**

MBIE awarded a Vision Mātauranga grant to Lincoln Agritech and Kāi Tahu ki Otago in July this year. The project runs until May 2018 and encompasses joint investigations of river condition and traditional freshwater food gathering species, including eel (tuna), whitebait (inaka), flounder (pātiki) and watercress (kowhitwhiti). Kāi Tahu ki Otago is the environmental and health agency for Otago rūnanga with marae at Moeraki, Karitane, Ōtākou and Muruhiku, and is providing Kathryn Gale as local researcher under the guidance of Gail Tipa (Tipa Associates) and Jens Rekker (Lincoln Agritech).

**Owl Farm wetland project**

St Peter's School in Cambridge and Lincoln University are collaborating in the Owl Farm demonstration dairy farm partnership on developing a workable blueprint of sustainable, profitable dairying (http://www.owlfarm.nz). A wetland treating diffuse groundwater discharge has recently been established on the farm to reduce nutrient inputs into the adjacent Waikato River. Staff from Lincoln Agritech's Hamilton office support this project by providing expertise on the monitoring of water and nutrient flows into and out of the wetland (Fig. 1).

*Fig. 1: Brian Moorhead and Tasman McKelvey installing a groundwater monitoring well upslope of the freshly planted wetland.*

**Staff changes**

Aldrin Rivas has recently taken up a position as Catchment Hydrologist based in our Hamilton office. He is just about to submit his PhD thesis titled "Characterisation of Denitrification in the Subsurface Environment of the Manawatu River Catchment" at Massey University. Aldrin comes to us with a lot of experience having worked in the fields of water & environmental science, engineering, and management for many years before returning to study.

*Fig. 2: Aldrin Rivas joining Lincoln Agritech at Ruakura.*

Compiled by Roland Stenger

## AgResearch Ruakura

The Pastoral 21 Research team (AgResearch, DairyNZ, Plant & Food, Lincoln and Massey Universities) convened for a two day workshop with investors in Lincoln on 20th-21st October. This annual get together is a valuable opportunity to review the progress of the science, do some planning and visit some experiment sites. On the latter, **Derrick Moot**, **Alistair Black**, **Keith Cameron** and **Grant Edwards** from Lincoln University did a great job hosting us at Ashley Dene to see some of the sheep grazing trials and have a look around the new dairy farm infrastructure, some of which is currently being used in the P21 Programme. We did our best to bring some much needed rain to Canterbury with us at the time, but our field trip only enticed a few mm. The final workshop for P21 will be next autumn.

*Photo above: Ross Monaghan and Keith Cameron inspecting the new facilites at Asheley Dene.*

The Environmental Research team (formerlly known as the Nutirent managment and environmental footprinting team) recently had a field trip to look at some research sites in the Waikato. This year they visited a dairy goat operation *(pictured left*) and a dairy farm on peat soils that is the site of a sustainable farming fund (SFF) project.

In November, **Gina Lucci** organised a farm visit and workshop on the topic of integrating trees in the dairy farm system. The group was hosted by farmer Grahame Smith on his dairy farm outside Kihikihi where he grows paulonia trees (*Pictured below*) along his fence lines for addional income, and is interested in how they might affect nitrogen leaching. The group assembled included people from AgResearch's People and Agriculture team and Farm Systems team along with people from DairyNZ, NZ Landcare Trust, Plant and Food, Fonterra, Waikato Regional Council, Ballance AgriNutirents and Waikato Farm Forestry.

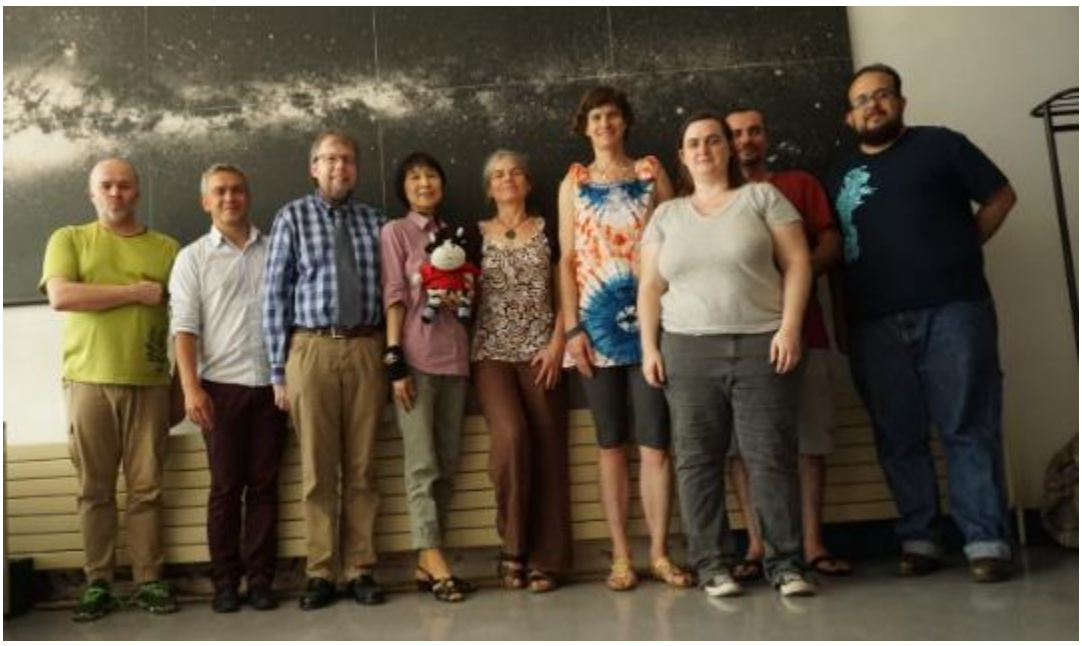
There are some new students joining us over the summer, and beyond from Waikato University: **Emily Thom** will be working largely with **Jiafa Luo** in the GHG space, and **Krystyn Numa** will be working mainly with **Diana Selbie** and **Mark Shepherd** on P21-related projects.

And last, but certainly not least, **Natalie Watkins** is pleased to announce the latest release of Overseer 6.2.3. This was a maintenance release with a number of changes to the engine and user interface.

## Manawatu/Hawke's Bay

## Plant & Food Research – Palmerston North

Plant & Food Research's Production Footprints team is collaborating with researchers from France, Italy, Denmark, New Zealand, Mexico and Japan in the European-funded H2020 project *PROTINUS 'PROviding new insighT into INteractions between soil fUnctions and Structure'*. In July 2016, the *PROTINUS* team held its first summer school on methodologies used for 3D observations of porous media in Grenoble, which attracted about 20 postgrad students (http://www.protinus.ird.fr/). **Karin Müller** also visited the project partners Laboratoire d'étude des Transferts en Hydrologie et Environnement (LTHE) and Aalborg University. In France, progress was made on the image analysis of CT images of kiwifruit orchard soils, which had been scanned during a previous visit. Together with Danish colleagues, Karin started exploring the potential of vis-NIR spectroscopy to indirectly determine water repellency of soils. About 165 soil samples from New Zealand, Japan and Denmark exhibiting broad ranges in carbon and clay contents were vis-NIR scanned. Preliminary results yielded successful predictions of the organic carbon contents as well as the degree of repellency. In October 2016 **Robert Simpson** visited Jean Martins at LTHE, Grenoble. Working in conjunction with Jean Martins, he developed and modified methods to measure bacteria-originated break down of toxic compounds in soils. This will contribute to determining the roles of different soil fractions in the removal of contaminants from soils.



*Third PROTINUS team meeting in Grenoble, France: Patrice Delmas (Auckland University), Olivier Guiraud (Novitom); Per Moldrup (Aalborg University), Toshiko Komatsu (Saitama University), Karin Müller (Plant & Food Research), Céline Duwig (LTHE), Anne-Julie Tinet (GeoRessources, University Lorraine), Laurent Oxarango (University Grenoble), Alfonso Gastelum Strozzi (University of Mexico City).*

**Purak Patel**, summer student working with **Karin Müller** and Richard Oliver, joined the team on 14th November. He is studying Engineering at Waikato University and will be based at Ruakura to test, improve and finalise the designs of an automated tension disc infiltrometer (field) and a lab solute transport apparatus.

**Ian McIvor** and **Trevor Jones** attended and gave presentations at the International Poplar Commission 25th meeting in Berlin in September. **Ian** was elected to the Executive committee of the International Poplar Commission for the next four years at the meeting. Ian gave a seminar at Rothamsted Research Centre, UK and attended the World Silvopastoral conference in Evora, Portugal. Working party meetings were held in rooms built for the original university in 1556. Pillars did get in the way of the presentations but who would want it any different.

**Trevor Jones** joined the post-conference tour of Central Germany. This included visits to natural stands of European Black Poplar (*P. nigra*) on the Elbe and Rhine Rivers, a bioenergy village that is using short rotation coppice (SRC) poplar and willows for renewable energy production, and a national series of SRC field trials of poplars and willows that are being used to estimate potential yields in Germany.

Conservation of the native European Black Poplar (*Populus nigra*) along the rivers in Germany is hampered by the demands for improved flood protection, and the conflict this has with the re-generation of threatened floodplain forests. An interdisciplinary approach is being used with ecological and hydraulic 2D modelling, to identify sites suitable for floodplain forest regeneration without negative hydraulic effects. Another issue that affects the genetic resources of natural stands of *P. nigra* is interbreeding with the surrounding plantations of hybrid *P. deltoides* x *P. nigra* trees. The use of DNA markers has shown that 5 to 18% of young poplar trees in natural stands of *P. nigra* along the riverbanks of the Elbe and Rhine Rivers have *P. deltoides* parentage.

The bioenergy village Beuchte in Lower Saxony converted from a natural gas heating system to a wood chip heating system for 65 households in 2008, as part of Germany's programme to increase renewable energy use. A 250 kW wood chip fired boiler and a 2.5 km heating network were installed, and five percent of the agricultural land was converted to SRC poplar plantations to provide the wood chips for the heating system. The project was supported by a large grant from the German government, that made it financially viable, and it has also benefited by being able to utilise methane gas produced by a biogas plant at the local piggery to dry the wood chips prior to storage.

Short rotation coppice (SRC) field trials of the most common poplar and willow clones used in SRC cultivation in Germany ('Max 1', 'Hybride 275'/'NE42', 'AF2', 'Inger', 'Tordis') were established in 2008 on 38 sites with a diverse range of soil and climatic conditions in Germany. The trials were funded by the German Federal Ministry of Food and Agriculture, and grown on 3 year rotation cycles, and planted at 0.5 x 1.8 m spacing (11,111 trees/hectare). We visited the Unterrieden trial site in North Hesse, now in its third rotation (Figure 1). The biomass yields of the trials have increased in the second rotation cycle compared with the first, with noticeable differences between the poplar and willow clones, and sites. Based on the findings, the intention is to develop a set of tools for estimating potential yields with a given set of environmental variables, as part of a decision support system for potential SRC growers.

*Short rotation coppice (SRC) field trial at the Unterrieden site in North Hesse, Germany, showing three years coppice growth on the 'Tordis' willow clone.*

**Brent Clothier** and **Steve Green** spent September in the United Arab Emirates working with Environment Agency Abu Dhabi on two projects, both aimed at reducing irrigation usage in the hyper-arid UAE. These projects are:

**Irrigation of arid forests using treated sewage effluent (TSE).** This work involves EAD scientist Wafa Al Yamani, and as part of this project she is doing her PhD through the Plant & Food-Massey University joint graduate school. Her work involves replacing groundwater for irrigation with TSE. Sapflow and TDR equipment have been installed in four arid-forest species: Al Ghaf, Sidr, Arak and Samr. Here Wafa is using a light stick to measure the Sidr trees' leaf areas to assess the impact of TSE irrigation of tree performance

*Wafa Al Yamani using a light stick to measure the shadow area cast by a Sidr tree in order to infer the tree's leaf area. Sapflow gear can be seen in the branches of the tree.*

**Optimising the use of saline groundwater to irrigate data palms**. The date palm research seeks to reduce the amount of water used to irrigate date palms, but this requires that there still be sufficient drainage to flush salts from the rootzone. So it is a fine balance between reducing irrigation and maintaining a salt leaching fraction. This work involves EAD scientist Ahmed Al Muaini who is also doing his PhD through the Plant & Food-Massey University joint graduate school. Ahmed passed his PhD confirmation exam on 16th November. Below Ahmed is shown downloading data from the dataloggers which are recording palm-tree sapflow, TDR-measured soil water content, and soil EC using CS655 probes. We are working on eighteen fully instrumented trees, across 3 data palm cultivars (Lulu, Shahlah and Khalas) at two salinities (5 & 15 dS/m).

## Landcare Research

**Scott Fraser** has been working on a SFF project with AgResearch, DNZ, WRC and local peat farmers. The project aims to develop guidelines for dairy farmers on peat around sustainable nutrient manage and farm effluent disposal. Scott is currently involved in developing a peatland classification that will allow peat farmers to assess the risk status of their land to nutrient and effluent loss to water. Recently Scott presented a summary of technical aspects of a peatland classification to the SFF peat group for discussion.


**Bryan Stevenson**, **Garth Harmsworth** and colleagues were successful in securing an MBIE bid around soil health and resilience. The project has three main objectives: 1) defining soil resilience and determining pedogenic thresholds, 2) developing concepts of Māori soil health, and 3) developing a broader and more unified soil health and resilience framework. Of particular interest to pedologists may be the concept of soil resilience and pedogenic thresholds. News from the bidding round came too late to incorporate sessions into the Queenstown meeting, but we will look to organise a section around this either at the next NZSS meeting in 2 years or the next combined meeting in 4 years.

*Ahmed Al Muaini downloading data loggers in the project of minimising the irrigation of date palms using saline groundwater. Sapflow gear can be seen in the date palm. There is 1.5 km of cabling across the experiment, and some 500 m of TDR rods have been installed.*

Brent and Steve will return to the UAE in December for another field campaign on both projects.

## Massey University, Palmerston North

Ranvir Singh travelled to Lombok (Indonesia) in September, a continuation of the relationship Massey University has with the University of Mataram in Eastern Indonesia with NZ MFAT-funding (http://www.ifsca.nz/). He went on to attend and present at an International Riversymposium (http://riversymposium.com/) held in New Delhi (India).

In Indonesia, Ranvir is contributing to a water feasibility study for horticulture production in North Lombok, where he met with local researchers (from the University of Mataram) to discuss geographical and hydrological information and analysis required for the study.

*Ranvir Singh with local researchers at the University of Mataram, Lombok (Indonesia)*

*Ranvir Singh assessing soil types and depth at a farmer field in North Lombok.*

At the International Riversymposium, Ranvir presented a case for water sensitive growth - not water intensive growth - in North Indian States, based on his knowledge and local Indian experiences. India is becoming a major exporter of grains and in 2013-14 produced about 103 million metric tonne (MT) of rice and 92 million MT of wheat. About 9.56 million MT of rice and 3.77 million MT of wheat were exported, mainly procured the states of Haryana, Punjab, Uttar Pradesh and Madhya Pradesh. This production is mainly supported by overexploitation of groundwater resources for irrigation of grain crops. As a result, groundwater levels are depleting at an alarming rate, particularly in the North-Western Indian States of Haryana and Punjab. Considering the intense use of water use at around 2000 litres per kg for rice production and 700 litres per kg for wheat production, the current level of rice and wheat exports from India roughly equates to an export of about 90 cm of groundwater level over the whole area of Haryana and Punjab combined! This needs to be addressed by investments in science, education, training, capability and capacity building to facilitate a shift to high-value water efficient sustainable agriculture production in the region.

*Ranvir Singh and Dr Salazar*

In October Ranvir also travelled to the Postgraduate School Universidad de Chile (Santiago), Chile at the invitation of Dr Osvaldo Salazar where he contributed to the teaching of a post-graduate course on 'topicos en manejo de aguas'. He also used this opportunity to discuss with Dr Salazar his column and field experiments to measure and model effects of nitrogen fertilization and cover crops on maize production and nitrogen leaching in a coarse-textured soil. A productive meeting was held with an environmental advisor of a European Food Retailer and representatives of a Local (Chilean) Wine Company to explore opportunities to fund and start two masters student research projects to assess current practices and identify scope for improvement of water and nutrient management practices in local vineyards.

Jon Procter and Kat Holt recently began fieldwork at Lake Horowhenua in partnership with the Muaupoko iwi and Lake Horowhenua Trust for their Vision Matauranga project '*Horo Whenua: Measuring the moving land through precision geomorphic analysis of the Punahau/Lake Horowhenua lakebed and surrounding areas*'. Kat and Jon spent 4 days at the lake, supported by IAE technician David Feek, and Dr Piet Verburg (NIWA) and collected 9 cores, totalling over 45m in length. The deepest cores preserve evidence for a major flood or marine inundation event, in the form of a thick sand layer, which may have played a role in the formation of the lake. Mauapoko Iwi members viewed the cores at a recent hui and wananga, where they stimulated much interest and discussion.

*Jon Procter with a section of lake sediment core*

The next steps for the project will involve obtaining radiocarbon dates for the core, and performing analyses to track nutrient levels and sedimentation rates throughout the lifetime of the lake. In addition to the VM project named above, this dataset will contribute to achieving goals of the MBIE Resilient Lakes project, Horizons Fresh Water Clean-up initiatives and the Horowhenua Lake Trust's MfE funded Te Mana o Te Wai program of restoration.

At the end of October we farewelled a very loyal servant – Liza Haarhoff - who has been the Soil and Earth Sciences Group Secretary for the last seven years. During that time we, along with many people from outside Massey, have appreciated her efficient, skilled, and cooperative support as she dealt with the many demands of this pivotal position. Anyone who can manage Mike Hedley and attend to his busy schedule deserves a medal! A lot of students and external collaborators have had cause to liaise with Liza during her time with us, and have appreciated such a helpful and friendly person being in this pivotal position.

Liza is staying with Massey and has taken a role in the Teaching and Learning Unit that will more directly use and allow her skills in design and web development to grow. Thankfully, the needs of the Soil & Earth Sciences and FLRC will be high on her agenda as we look to develop or transfer courses to the on-line environment.

Fiona Bardell has taken up the position of Soil & Earth Sciences Group Secretary.

The Fertilizer & Lime Research Centre (FLRC) will hold the 30th Annual Workshop in February at Massey University, Palmerston North. The title for 2017 is:

'SCIENCE AND POLICY: NUTRIENT MANAGEMENT CHALLENGES FOR THE NEXT GENERATION'

This is a milestone event for FLRC and the Organising Committee are putting together a programme worthy of this momentous occasion. An invitation to present a Keynote address has been accepted by Professor Brian Kronvang from the National Environmental Research Institute, University of Aarhus, Silkeborg in Denmark. The status of research in Demark (in the agriculture and environment space) has parallels to what is occurring in New Zealand. Policy implementation has proven to be problematic and the Government has had to back down on regulations following protests by farmers. Gaps in science have been identified and efforts are being made to come up with workable mitigation strategies. A Provisional Programme for the FLRC Workshop should be available on line (http://flrc.massey.ac.nz/) before the end of 2016 and details about registration can be found on this site.

The Fertilizer and Lime Research Centre have hosted these meetings annually at Massey University since 1987. They have become established as an effective mechanism for information transfer amongst industry, science, policy and regulatory personnel concerned with primary production in New Zealand. See elsewhere in this issue to source information about the FLRC Workshop.

## Canterbury

### Lincoln University

Congratulations to Prof Hong Di for being elected as a Fellow of the Royal Society of New Zealand. This is an honour which reflects well on the Faculty and University. Nineteen top New Zealand researchers and scholars with a range of research interests, backgrounds and places of work were announced as Fellows of the Royal Society of New Zealand at a recent forum, an honour which recognises true international distinction in research and scholarship. Professor Di, has led pioneering research, scholarship and technology developments on ammonia oxidisers in the soil, nitrate leaching and nitrous oxide emissions. His research has significantly improved understanding of the role of bacteria and archaea in nitrogen cycling. He is recognised internationally for his work on nitrification inhibitors which contributes to the development of innovative environmental technologies to mitigate nitrate leaching and nitrous oxide emissions.

Congratulations to Salome Seyedalikhani (left) and Minakshi Mishra (middle) for wining first places at the Postgrads Conference (24 -25 August). Salome's title was "Freshen up your poo and earn money too" and Minakshi's title was "Mānuka and kānuka to clean-up New Zealand's waterways". Shamim Al Mamun (right) took 2nd place, his title was "Low-cost method to reduce the transfer of cadmium from soil to plants. All three students are supervised by Brett Robinson.

Jen Owens has successfully defended her PhD thesis entitled "*The influence of irrigation on nitrous oxide fluxes from a grazed and fertilized pasture*". Jen's supervisors were Prof Tim Clough , Dr Nik Lehto, Dr Johannes Laubach and Dr John Hunt (Landcare). Congratulations and well-done Jen.

# Abstracts

## Discovery of halloysite books in altered silicic Quaternary tephras, northern New Zealand

**M.J. Cunningham[1], D.J. Lowe[1], J.B. Wyatt[1], V.G. Moon[1] and G.J. Churchman[2]**
[1]School of Science, Faculty of Science and Engineering, University of Waikato, Hamilton 3240, New Zealand
[2]School of Agriculture, Food and Wine, University of Adelaide, Adelaide 5005, South Australia, Australia

Abstract
Hydrated halloysite was discovered in books, a morphology previously associated exclusively with kaolinite. From ~1.5 µm to ~1500 µm in length, the books showed significantly greater mean Fe contents ($Fe_2O_3$ = 5.2 wt%) than tubes ($Fe_2O_3$ = 3.2 wt%), and expanded rapidly with formamide. They occurred, along with halloysite tubes, spheroids, and plates, in highly porous yet poorly-permeable, silt-dominated, Si-rich, pumiceous rhyolitic tephra deposits aged ~0.93 Ma (Te Puna tephra) and ~0.27 Ma (Te Ranga tephra) at three sites ~10–20 m stratigraphically below the modern land-surface in the Tauranga area, eastern North Island, New Zealand. The book-bearing tephras were at or near saturation, but have experienced intermittent partial drying, favouring the proposed changes: solubilized volcanic glass + plagioclase → halloysite spheroids → halloysite tubes → halloysite plates → halloysite books. Unlike parallel studies elsewhere involving both halloysite and kaolinite, kaolinite has not formed in Tauranga presumably because the low permeability ensures the sites largely remain locally wet so that the halloysite books are metastable. An implication of the discovery is that some halloysite books in similar settings may have been misidentified previously as kaolinite.

*Clay Minerals* (2016) **51**, 351-372. **DOI:** 10.1180/claymin.2016.051.3.16

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## Unique but diverse: some observations on the formation, structure and morphology of halloysite

**G.J. Churchman, P. Pasbakhsh[2], D.J. Lowe[3] and B.K.G. Theng[4]**
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Abstract
New insights from the recent literature are summarised and new data presented concerning the formation, structure and morphology of halloysite. Halloysite formation by weathering always requires the presence of water. Where substantial drying occurs, kaolinite is formed instead. Halloysite formation is favoured by a low pH. The octahedral sheet is positively charged at pH < ~8, whereas the tetrahedral sheet is negatively charged at pH > ~2. The opposing sheet charge would facilitate interlayer uptake of $H_2O$ molecules. When halloysite intercalates certain polar organic molecules, additional (hkl) reflections appear in the X-ray diffractogram, suggesting layer re-arrangement which, however, is dissimilar to that in kaolinite. Associated oxides and oxyhydroxides of Fe and Mn may limit the growth of halloysite particles as does incorporation of Fe into the structure. Particles of different shape and iron content may occur within a given sample of halloysite.

*Clay Minerals* (2016) **51**, 395-416. **DOI: 10.1180/claymin.2016.051.3.14**

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## Halloysite behaving badly: geomechanics and slope behaviour of halloysite-rich soils

**V.G. Moon**
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Abstract
Halloysite-rich soils derived from in situ weathering of volcanic materials support steep stable slopes, but commonly fail under triggers of earthquakes or rainfall. Resulting landslides are slide-flow processes, ranging from small translational slides to larger rotational failures with scarps characteristic of sensitive soils. Remoulding of failed materials results in high mobility flows with apparent friction angles of 10-16°. The materials characteristically have high peak friction angles (~25-37°), low cohesion (~ 12-60 kN $m^{-2}$) and plasticity (plasticity index ~10-48%), and low dry bulk density (~480-1080 kg $m^{-3}$) with small pores due to the small size of the halloysite minerals. They remain saturated under most field conditions, with liquidity indexes frequently > 1. Remoulded materials have limited cohesion (< 5 kN $m^{-2}$) and variable residual friction angles (15-35°). Halloysite mineral morphology affects the rheology of remoulded suspensions: tubular minerals have higher viscosity and undrained shear strength than spherical morphologies.

*Clay Minerals* (2016) **51**, 517-528. DOI: 10.1180/claymin.2016.051.3.09

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## A new attraction-detachment model for explaining flow sliding in clay-rich tephras

**Max O. Kluger[1], Vicki G. Moon[2], Stefan Kreiter[1], David J. Lowe[2], G.J. Churchman[3], Daniel A. Hepp[1], David Seibel[1], M. Ehsan Jorat[4], and Tobias Mörz[1]**
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[3]School of Agriculture, Food and Wine, University of Adelaide, Adelaide 5005, Australia
[4]School of Science, Engineering and Technology, Abertay University, Dundee, DD1 1HG, UK

Abstract
Altered pyroclastic (tephra) deposits are highly susceptible to landsliding, leading to fatalities and property damage every year. Halloysite, a low-activity clay mineral, is commonly associated with landslide-prone layers within altered tephra successions, especially in deposits with high sensitivity, which describes the post-failure strength loss. However, the precise role of halloysite in the development of sensitivity, and thus in sudden and unpredictable landsliding, is unknown. Here we show that an abundance of mushroom-cap-shaped (MCS) spheroidal halloysite governs the development of sensitivity, and hence proneness to landsliding, in altered rhyolitic tephras, North Island, New Zealand. We found that a highly sensitive layer, which was involved in a flow slide, has a remarkably high content of aggregated MCS spheroids with substantial openings on one side. We suggest that short-range electrostatic and van der Waals' interactions enabled the MCS spheroids to form interconnected aggregates by attraction between the edges of numerous paired silanol and aluminol sheets that are exposed in the openings and the convex silanol faces on the exterior surfaces of adjacent MCS spheroids. If these weak attractions are overcome during slope failure, multiple, weakly-attracted MCS spheroids can be separated from one another and the prevailing repulsion between exterior MCS surfaces results in a low remolded shear strength, a high sensitivity, and a high propensity for flow sliding. Our evidence indicates that the attraction-detachment model explains the high sensitivity and contributes to an improved understanding of the mechanisms of flow sliding in sensitive, altered tephras rich in spheroidal halloysite.

*Geology* (2016) (in press) **DOI:** 10.1130/G38560.1

## Conferences:

NZASSS
NZ SOCIETY OF SOIL SCIENCE & SOIL SCIENCE AUSTRALIA

# 'Soil, a Balancing Act Down-under'

**Still time to Register!**

There is still time to register for the joint conference of the New Zealand Society of Soil Science and Soil Science Australia. The overarching theme of the conference is 'Soil, a Balancing Act Down-under' and reflects the challenges we are facing in managing our soils to reach a careful balance between the many, often competing, land-use, productivity and environmental aspirations of today.

**Where: Millennium Hotel, Queenstown, New Zealand**

**When: 12-16 December 2016**

**You can register right up to the first day of the conference at www.nzassconf.co.nz**

**Panel Discussion**

One of the features at this year's conference is a panel discussion on the key challenges that land-use decision makers will be facing in the future, and the role of soil science and soil scientists to provide solutions to address these. The discussion will be moderated by Kim Hill of Radio New Zealand.

**Date: Thursday, 15 December 2016**
**Time: 3:30pm - 5:00pm**

Here's a little more information about the four participants of the Discussion Panel:

**Andy MacFarlane**

Andrew is the Founding Director of Macfarlane Rural Business Ltd and has been a practicing farm management consultant since 1981. He is chairman of Deer Industry NZ and Past President of the NZ Institute of Primary Industry Management. He has a keen interest in building businesses and investment portfolios. He is a director of ANZCO Foods Ltd, AgResearch, and Ngai Tahu Farming, and a Councillor of Lincoln University and Chairman of Deer Industry NZ.

Andrew has been a past winner of the Ballance Farm Environment Awards Canterbury (2003) and runner up of the Lincoln University Foundation South Island Farmer of the Year (2007). He has a Bachelor of Agricultural Science and is a Member of the Institute of Directors. Andrew has a particular interest in building depth in both the numbers and quality of young professionals entering the rural sector and expertise in developing environmentally sound farm management systems, particularly in relation to irrigation schemes and on-farm land use options.

**Bob Gilkes**

Bob is a world-renown researcher in soil-mineralogy, fertiliser chemistry, mine site rehabilitation and management of soil, water and other resources. A former Winthrop Professor of Soil Science, Bob is a Senior Honorary Research Fellow at the University of WA, a recipient of the Prescott Medal for outstanding contribution to soil science and a Crawford Medal recipient for his lifetime contribution to research supervision, mentoring overseas students and contribution to building capacity in developing countries for food security. Bob is highly regarded by former students and the WA farming community.

**Jacqueline Rowarth**

Jacqueline holds the new position of Chief Scientist for the Environmental Protection Authority. Until the end of October she held the Foundation Chair in Agribusiness at the University of Waikato, a position she held from 2012, having spent the previous five years in the role of Director of Massey Agriculture and Foundation Chair of Pastoral Agriculture, at Massey University. She has also taught at University of Melbourne and Lincoln University, plus worked for DSIR Grasslands/Agresearch from 1988 to 1994.

Jacqueline obtained a PhD in soil science from Massey University, having completed a B.Ag.Sci with honours in Environmental Agriculture. She was made Companion of the New Zealand Order of Merit for services to agricultural science in 2008. She is a Past President of the New Zealand Grassland Association and the New Zealand Institute of Agricultural and Horticultural Science, a past trustee of AGMARDT, and a past Director of Crop and Food Research.

**Susie McKeague**

Susie completed a Bachelor of Agricultural Science at Queensland University in the late 80's. She is currently a farm environmental consultant and director of McKeague Consultancy, based in Dunedin, Otago, where she provides a consultancy service to farmers and farmer owned irrigation companies in the Otago and Canterbury regions. Much of her work relates to providing advice on water quality and quantity issues. Susie was previously employed for 12 years by the Otago Regional Council as Manager of the Land Resource Unit, where she maintained a valuable role liaising between farmer groups and the Regional Council.

Before moving to NZ Susie worked in the Western Australian wheatbelt in a variety of roles including research into soil water movement, Landcare officer and project management. The challenge of designing and applying environmental regulation in an effective and practical way keep her motivated and passionate about her work with the rural sector.


**25 - 27 January 2017**

The International Plant Nutrition Institute is pleased to invite you to participate in the upcoming international conference designed to exchange information on how to improve potassium plant nutrition and soil management to better the health of soils, plants, animals, and humans. The 4R Nutrient Stewardship framework is integrated into the conference structure to keep the discussions anchored to the information needs of farmers and those who provide nutrient management guidance.

**Website:** http://kfrontiers.org
**Location:** Rome, Italy

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*A conference on the cutting edge of science, management and policy to minimise effects of agriculture and land use changes on the quality of groundwater and surface waters.*

**LuWQ2017**
**3rd International Interdisciplinary Conference on LAND USE AND WATER QUALITY:**
***Effect of Agriculture on the Environment***
**The Hague, the Netherlands, 29 May – 1 June 2017**

More information is on http://www.luwq2017.nl/

**Objectives**

This conference aims to discuss the entire policy cycle for water quality improvement. This cycle includes problem recognition, formulation of technical options, the process of policy development, interaction with policy makers, stakeholders and pressure groups, policy implementation, monitoring and research. This conference also aims to intensify contacts, on the one hand, between scientists with a background in natural sciences and scientists with a background in social and economic sciences and, on the other hand, between scientists, water managers and policy makers. In short, the objectives are:

- to provide forum for exchange of scientific knowledge, research on system knowledge, modelling and uncertainty;
- to discuss the entire policy cycle for water quality improvement;
- to intensify contacts (a) between soil/water related scientists, agro related scientists, social scientists, ecological scientists and economists, and (b) between scientists, water managers and policy makers.

LuWQ2017 is the follow-up to the successful LuWQ conferences, LuWQ2015 held in Vienna, Austria, in September 2015 and the LuWQ2013 conference held in The Hague, the Netherlands, in June 2013.

**Target groups and keywords**

Target groups (professionals, fields of expertise, audience) are scientists, managers and policy makers involved in the policy cycle for water quality improvement. The conference deals with themes and topics characterised by the following keywords:

- **Keywords for fields of expertise and scientific disciplines:** agronomy, agro-economics, agro-sociology, water management, water policy, action plan, river basin management plan, hydrology, soil science, drinking water supply
- **Keywords for system description:** aquatic ecosystems, terrestrial ecosystems, unsaturated zone, groundwater, surface waters, monitoring, modelling, chemical water quality, biological water quality, nitrate vulnerable zones, river basins, catchments
- **Keywords for best management practices:** buffer zones, sedimentation ponds, constructed wetlands, incorporation of fertilisers, catch crops, erosion control, cost effectiveness, voluntary measures, laws and regulations
- **Keywords for substances:** nutrients, nitrate, phosphorus, pesticides and other organic agrochemicals, heavy metals.

**May 2017**

14-18 May The 15th International Symposium on Soil and Plant Analysis (ISSPA), Nanjing, China. ISSPA is devoted to the science and practices of soil, plant, feed, animal waste, and water analysis. This symposium provides an opportunity for international scientists interested in agricultural testing and results interpretations to exchange knowledge, foster collaborations, and learn advanced analytical technologies and laboratory management strategies. The registration is open. Please consider presenting a paper, becoming a sponsor/exhibitor. For more information, please visit http://isspa2017.csp.escience.cn/dct/page/1

**20 – 23 June 2017**

The Second Global Workshop on Digital Soil Morphometrics at The James Hutton Institute in Aberdeen, Scotland UK. For more information see http://www.digitalsoilmorphometrics.org

**26 June - 1 July 2017**

The 25th anniversary of Pedometrics will be celebrated in Wageningen, the Netherlands. Pedometrics is a branch of soil science dedicated to the application of mathematical and statistical methods for the study of the distribution and genesis of soils. Abstract submissions are now open for conference topics ranging from 'big data, data mining and machine learning for soil science' to 'proximal soil sensing'. The organisers are also calling for submission of proposals for pre-conference workshops. Pedometrics 2017 is organised by the Pedometrics Commission of the International Union of Soil Science and its Working Groups: Stay up to date at http:// www.pedometrics2017.org/ or contact info@pedometrics2017 with specific questions, suggestions or requests.

**3 – 7 September 2017**

**http://www.som2017.org/index.php?id=14387&L=1&type=300**

**6th International Symposium on Soil Organic Matter**

3–7 September 2017 • Harpenden/UK