

PROGRESS REPORT 3

Coastal Acid Sulfate Soils Program (CASSP) 30th September 2002

South Australian Inventory of Acid Sulfate Soil Risk (Atlas)

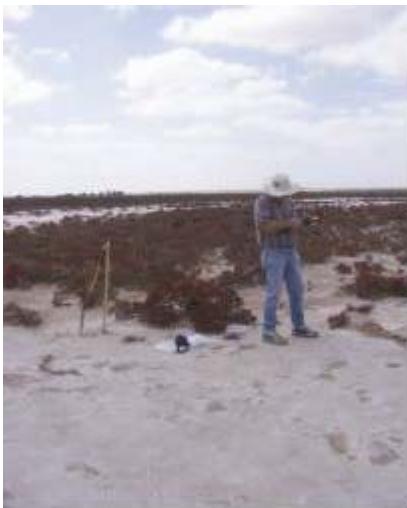


**Sampling site CA 61 (intertidal
samphire from upper Gulf St Vincent)**

**See Section 3.2 in this report for more
information about these potential acid
sulfate soils**



**Site CA 19 (a salt pan from western
Eyre Peninsula)**



**Site CA 1 (a gypseous salt pan at
Wallaroo, western Yorke Peninsula)**

PROGRESS REPORT 3

Coastal Acid Sulfate Soils Program (CASSP) Milestone Report: 30th September 2002

1. **Project title:** South Australian Inventory of Acid Sulfate Soil Risk (Atlas)

2. Contact Details

Organisation: CSIRO Land and Water

Project Manager: Mr Richard Merry.

Phone: 08 8303 8422

Fax: 08 8303 8550

Email: richard.merry@csiro.au

Postal Address: PMB No 2

Glen Osmond

South Australia, 5064

3. Key Dates

Project start date: 15th October 2001

Contract completion date: 31st December 2002 (report 28th February 2003)

Project progress up to: 30th September 2002

4. Project activities

Stage 3 of the project was to start at 1/07/2002 and finish 30/09/2002. The agreed activities and milestones are shown below.

	Activities	Milestones
3.1	Finalise Atlas and Report	Atlas and Report completed
3.2	Complete laboratory characterisation	Laboratory characterisation and analysis completed and samples prepared and archived
3.3	Develop a checklist of information required from proponents of development in coastal ASS	Checklist developed and accepted by Coast Protection Board
Progress Report 3 Report against key milestones and performance indicators, including a statement of costs to be lodged with the Department within 30 days of completion of Stage 3. - Due date 30/09/2002		

All milestones have been met. A report against each milestone follows.

Report against Milestones

Activity 3.1 Finalise Atlas and Report.

Milestone 3.1 Atlas and Report (plan) completed.

Report: Milestone met

The basic Atlas maps have been complete for some time. Examples were presented in Milestone Report 1. However, with the acquisition of soil chemical and some other data, the interpretation of some soil classes and the map legend will need to be modified, but we foresee no significant changes to map boundaries. These will come together with the preparation of the final WWW-based atlas.

The Report, that is the full account of the atlas map, risk categories, field site information, policy statements and risk guidelines cannot be fully complete until the final web-based product is in place with agreement from appropriate agencies. During the project, we have accumulated information on more than 70 field sites and several hundred individual soil samples. This information exists at present as computer files of various kinds. Our aim will be to assemble these as a web report that is appropriate to the medium and acceptable to the SA Department of Environment and Heritage, who manage the SA Digital Atlas web site. We have developed the following plan for the presentation of material on the web and have had discussions with DEH staff:

Introduction

- Reasons for risk maps and soil characterisation
- Brief definition of PASS and AASS
- Hot links to strategy and guidelines documents

Web atlas map with legend (part of SA Digital Atlas)

- Explanation of legend, risk classes

Site information

- Site identifier
- Site information
 - Georeference
 - Landform and geomorphology
 - Vegetation
- Images appropriate to site, eg landscape, soil materials, developments
- Brief description of soil
- Soil classification (user friendly, Australian, US Soil Taxonomy, World Soil Reference Base – as appropriate)
- Soil analytical data
- Notes appropriate to site relating to ASS.

Activity 3.2 Complete laboratory characterisation.

Milestone 3.2 Laboratory characterisation and analysis completed and samples prepared and archived

Report: Milestone met

Field soil samples were prepared and archived in several ways. Each significant soil sample was subsampled in the following ways:

- a) Approximately 200 g retained and frozen

- b) Approximately 50 g placed profile horizon order in plastic percussion sample trays and frozen
- c) A 100 ml sample of wet soil placed in a plastic phial and freeze dried
- d) A bulk sample of up to 500 g air dried in a forced draught oven at 40°C, lightly ground to pass a 2mm sieve and stored. The proportion of material greater than 2 mm material was determined, inspected and characterised as shell, calcium carbonate, gypsum or organic matter.

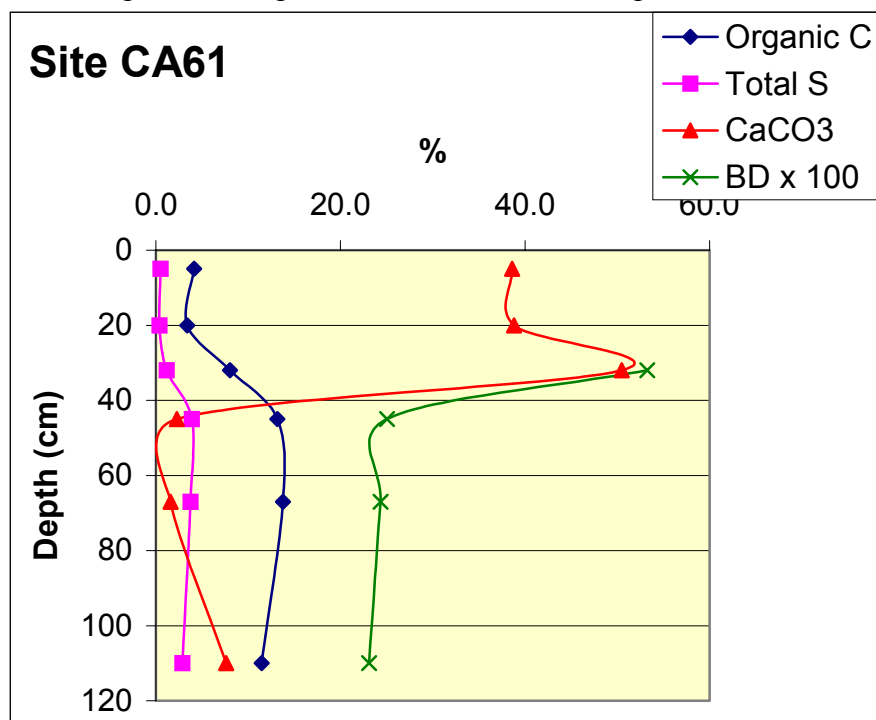
Selected samples were also retained for specialised analysis for salt and iron mineral identification (XRD). All samples have been stored for future reference. Subsample c) was retained for determination of water content and calculation of dry bulk density (see Milestone 2 report) and selected samples used to confirm the presence of inorganic sulfides (Cr reducible sulfide). The < 2 mm material of subsample d) was used for laboratory determination of:

- Total carbon (by LECO furnace)
- Total sulfur (by LECO furnace)
- Carbonate carbon (by modified CO₂ gas pressure calcimeter).

Soil organic carbon can be estimated by subtraction of carbonate carbon values from total carbon.

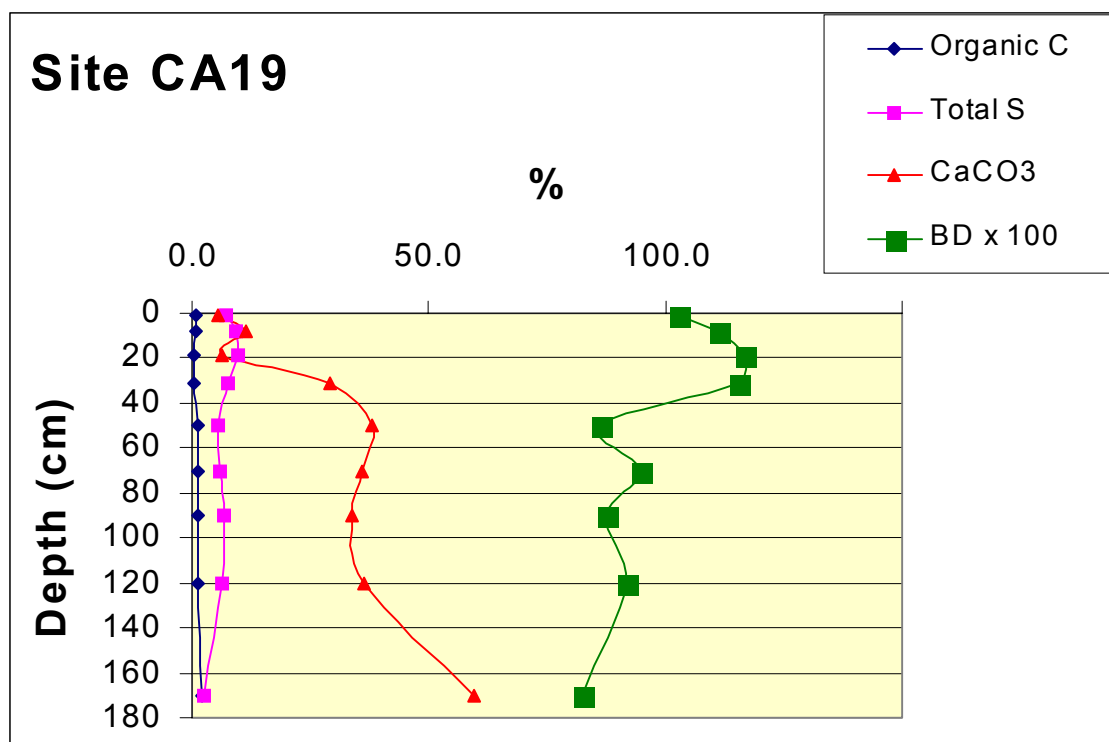
Planned laboratory characterisation and analysis is essentially complete, although it is normally expected that a few confirmatory analyses will be required. Although we expect that with storage there has been oxidation of sulfide forms in the freeze dried samples, selected samples these were analysed for Cr reducible S to confirm its presence. Field measurements with platinum electrodes were also used at some locations to confirm that the sulfur present must be in a reduced form.

Data from three field profiles are presented here with brief explanation.



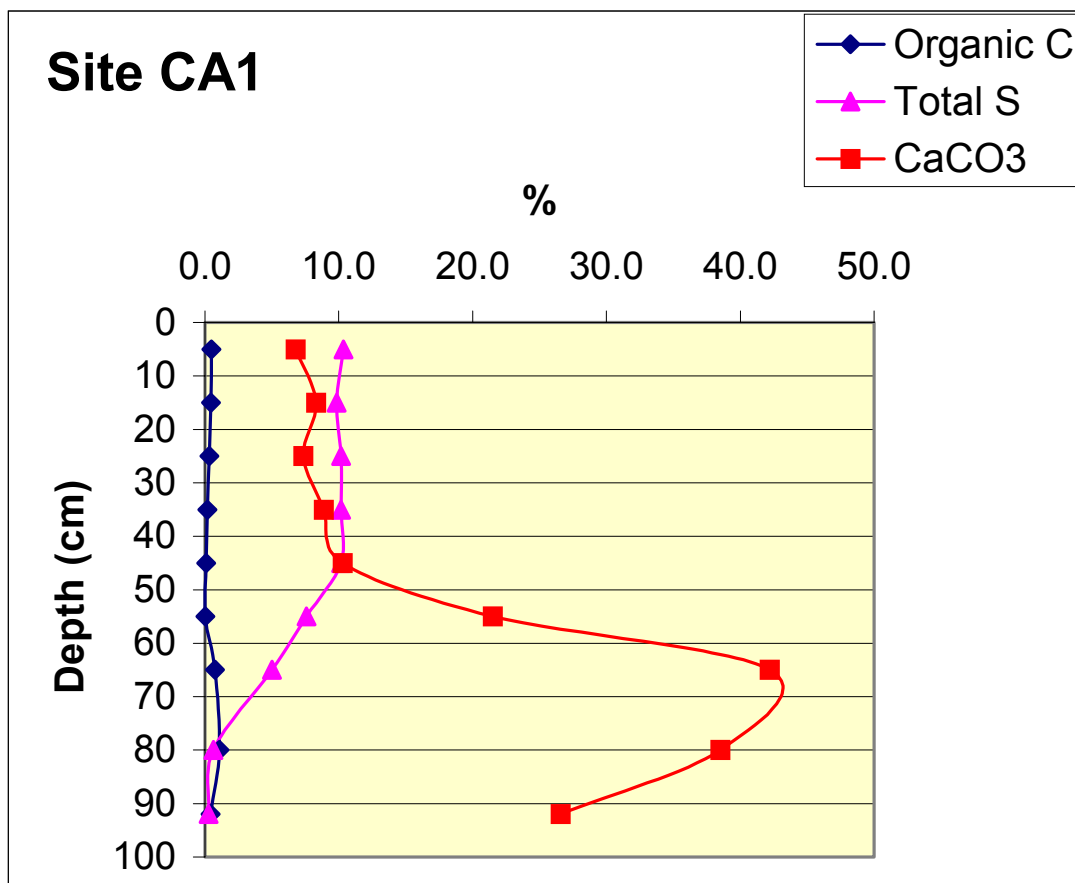
Site CA61 was sampled from intertidal samphire at Price on upper Gulf St Vincent. About 40 cm of calcareous clays (probably with a significant terrestrial input) overlies about 100 cm of relict peaty mangrove soil and underlain at 140 cm by coarse shelly material (not

sampled). The watertable at sampling was at about 15 cm. The peaty material was characterised by a high organic carbon and total sulfur with a strong H₂S smell. The dry bulk density of the peaty layer was about 0.25 g/cc. Although the top 40 cm was significantly calcareous, the reduced peaty layer contained insufficient acid-neutralising carbonates to neutralise the acid potentially produced should the material be exposed to the air. The presence of the peaty layer about 100 cm thick also presents a high risk if de-watering under load with consequent consolidation.



Site CA19 was sampled from a salt pan near Clare Bay, western Eyre peninsula. In this region, soils have a high sulfur content, often as gypsum and large gypsum deposits are mined nearby. In this profile, sulfur is present in the oxidised form at the surface and gypsum was also noted below about 20 cm, but with some black sulfidic material. We believe that periodic oxidation of sulfides has produced acid, which may have resulted in removal of calcium carbonate from the upper 20 cm of the profile. Nearby at the outflow of the salt pan, there was clear evidence of thinning of calcrete and significant formation of ferricrete (iron oxides), presumably from a long period of pyrite oxidation.

Site CA1 (below) was sampled at Wallaroo, upper Yorke Peninsula (western side). This site is proposed for development as a marina/residential complex. This site also contains sulfur as gypsum in the top 80 cm. Below about 50 cm there is significant calcium carbonate, with shell beds at about 100 cm. As it exists, this profile presents few risks. However, should the upper soil layers be relocated or buried below a water table, it is likely that reduction will convert the gypsum to pyrite and produce a possible future risk from acid sulfate conditions.



In summary, apart from the already recognised actual ASS area at Gilman, Adelaide, and some samples from near the Murray River mouth, the PASS materials encountered so far are predominantly in a natural state containing gypsum or reduced (sulfidic) form of sulfur that is tidally inundated at regular intervals. Of the latter, about 70 of 270 samples did not also contain sufficient calcium carbonate to fully counteract potential acidity (assuming all sulfur is in a reduced state). However, about 50 of these 70 samples contain sulfur as the oxidised form (sulfate) and under the current undisturbed and aerobic conditions are not considered a risk.

Activity 3.3 Develop a checklist of information required from proponents of development in coastal ASS

Milestone 3.3 Checklist developed and accepted by Coast Protection Board

Report: Milestone met

A Draft Checklist for Development in Coastal Acid Sulfate Soils has been written and is due for submission to the Coast Protection Board at their November 2002 meeting.

It is the third report in a series involving the Coast Protection Board's Coastal Acid Sulfate Soils Policy. The first two reports (appendices to Milestone Report 2) are:

1. Interim Strategy for Coastal Acid Sulfate Soils in South Australia; and
2. Interim Development Guidelines and Risk Assessment Criteria in South Australia.

The information contained within the report draws upon research and policy development from NSW and Queensland, as well as taking into account the unique aspects of South Australian coastal acid sulfate soils. It includes:

- strategic, environmental and remediation management plans addressing the main issues of coastal acid sulfate soil disturbance;
- instructions developed by the Queensland Government using five modules that provide direction when undertaking activities that disturb acid sulfate soils;
- aspects of the Queensland State Planning Policy Guideline on the treatment and management of disturbed acid sulfate soils, surface and drainage waters; and
- rehabilitation management techniques applicable to South Australia (Hicks *et al* 2001).

The Board is expected to endorse the Development Checklist as it did with the first two reports as an interim document. The planning review and CPB interim reports are to be submitted to Planning SA to contribute to their development of a whole of government coastal ASS development approach.

Additional Note:

Ms Shanti Ditter of the project committee has ceased with the Port Adelaide – Enfield Council and now works for the Holdfast Bay Council.

4. Brief description and analysis of Program Performance Indicators as per Item K.

Demonstration

- The second milestone report has been sent electronically to the NatCASS Steering Committee (project Steering Committee). Their next meeting is in late November.
- A representative from the State Planning Strategy and Policy Group (D Goodwins) has attended a recent project meeting. This contact is essential for the development of the whole of government approach to ASS with policy affecting both state and local government agencies.
- An abstract with poster (see Appendix) was presented at the 5th International ASSS Conference, Tweed heads, August 2002.
- Information regarding this project, including slightly modified milestone reports, is available at the following web addresses:

<http://www.ea.gov.au/coasts/programs/cassp/projects/sa-inventory.html>

http://www.per.clw.csiro.au/research/agriculture/acid/CASSP_SA_RiskMapping_Progress_Report1.pdf

- PDF files of the review, strategy and guideline documents annexed to Milestone Report 2 will be made available through the Coast and Marine Division website.
- An article on the project is being prepared for the “Coastlines” newsletter produced by the SA Coast Protection Board.
- Project personnel have been approached to undertake more consulting activities.

Technique Effectiveness

Because this project does not involve remediation or otherwise disturb the natural environment, no measures of technique effectiveness are appropriate. Conventional soil

chemical and physical analyses are being completed for regions where no data existed previously.

5. Provide a brief analysis of overall project progress to date.

The project is progressing well. Note that timing of approvals by other agencies cannot always strictly follow the expected timelines and milestones.

Chemical analyses have indicated significant amounts of PASS materials exist in areas that have potential for disturbance by development. Most soils contain significant acid neutralising capacity (ANC; as calcium carbonate) that will assist with management of PASS materials, but it is increased awareness of the presence of both ASS and ANC that is important.

The implementation and effectiveness of policy for management of coastal ASS will depend on a “whole of government” approach. The involvement of the State Planning Strategy and Policy Group is important to in this process.

Appendix Abstract of Poster Paper presented at the 5th International Acid Sulfate Soil Conference

Fitzpatrick R. W., P. G. Davies, B. P. Thomas, R. H. Merry, D. G. Fotheringham and W. S. Hicks (2002). Properties and distribution of South Australian coastal acid sulfate soils and their environmental hazards. 5th International Acid Sulfate Soils Conference, Tweed Heads, NSW, 25th to 30th August 2002. Book of extended abstracts. p. 40 –41.

Properties, distribution and environmental hazards of South Australian coastal acid sulfate soils

R W FITZPATRICK^{1,2}, P. J. DAVIES¹, B. P. THOMAS², R. H. MERRY¹, D. G. FOTHERINGHAM³, W. S. HICKS⁴ and E. L. BARNETT³

¹CSIRO Land & Water/ CRC LEME, Private Bag No. 2, Glen Osmond SA 5064

²CSIRO Land & Water/ University of Adelaide, Private Bag No. 2, Glen Osmond SA 5064

³Dept. of Environment & Heritage, SA Water House, 77 Grenfell St. 6th Floor, Adelaide, SA

⁴CSIRO Land & Water, GPO Box 1666, Canberra, ACT 2601

Keywords: Mapping acid sulfate soils, soil classification, mineralogy, Mediterranean climate, sapric material, mangrove dieback, redox potential.

Abstract

In Australia, coastal acid sulfate soils (ASS) occupy an estimated 40,000km², underlying coastal estuaries and floodplains near where the majority of the Australian population lives. The spatial distribution and processes operating in ASS from temperate, Mediterranean climate regions are poorly understood, as are the environmental hazards they pose.

A study is underway in South Australia to better understand ASS processes and distribution. At Gillman, near Adelaide, bunds constructed across mangrove swamps nearly 50 years ago cut off tidal flushing and drained areas resulting in the formation of ASS. Several soil transects have been carried out to determine the location, depth and thickness of sulfidic materials and sulfuric horizons, and the height of the watertable. Conceptual cross-sections of these transects show a wide range of different types of ASS in the tidal mangrove swamps and adjacent bunded areas. This approach has identified the inherent risk of forming actual ASS is related to the thickness and proximity to the surface and watertable of the underlying sulfidic material, and the type of organic matter that they contain.

The morphological, chemical and mineralogical properties of soils occurring in the modern intertidal mangroves at Gillman and surrounding area indicate they have A1 horizons with more than 15% organic carbon (i.e. Histosols), which consist of sapric material (highly decomposed organic matter) and sulfidic material (Soil Survey Staff 1999). The A1 horizon is generally underlain by unconsolidated Holocene coastal marine sediments consisting of saturated, light grey, shelly and often silty or clayey sands. Consequently, these Histosols classify as Terric Sulfisaprists. When these Sulfisaprists were drained and oxidised, the organic carbon content declined and sulfuric acid was produced to form a wide range of actual acid sulfate soils with sulfuric horizons. Where the organic carbon contents are low (<6 %) the soils classify as Hydraquentic Sulfaquepts, Salidic Sulfaquepts (hypersaline soils) or Haplic Sulfaquepts. The schematic cross-section illustrates how carbonates in the Petrocalcic Xerochrepts are being dissolved by the development of immediately adjacent

acid sulfate soils (Sulfaquepts). The calcium remaining after dissolution of the carbonates is retained in the system as authigenic gypsum crystals.

The sapric material identified in these soils is more finely divided and reactive than the coarser, "fibric" materials observed in tropical areas, where organic carbon decomposition rates are much faster. It is thought that the "sapric" materials in these South Australian soils form from the detritus of seagrass and mangroves in the Gulf St Vincent. Also, the intense reducing conditions (i.e. low redox potential or Eh values to -600 mv) occurring in potential ASS where mangrove dieback is present in the St Kilda area may be the result of increased nutrient loads (eutrophic conditions). These soil processes and materials must be better understood if effective approaches to management are to be developed.

The distribution of ASS in South Australia has also been investigated so that detrimental effects from future disturbance may be avoided. An inventory of ASS risk (with 9 ASS soil risk classes) in the form of classified maps for the South Australian coastline will be made available via an interactive GIS on the world wide web (<http://www.atlas.sa.gov.au/>). This multi-scale ASS atlas, is based on saltmarsh and mangrove habitat mapping by the South Australian Office for Coast and Marine (<http://www.atlas.sa.gov.au/>), mapped mainly from 1:10,000 and 1:15,000 colour aerial photography. ASS soil risk classes were developed using information gained from sampling along transects for which much detail of landform and vegetation was available. Linked to the ASS risk maps, Coast Protection Board ASS planning policy and assessment criteria are being developed for South Australia. It is expected that the outcomes from this study will provide a solid understanding of temperate ASS needed to manage similar soils elsewhere in southern Australia.

Reference

Soil Survey Staff (1999). Soil Taxonomy - a basic system of soil classification for making and interpreting soil surveys, Second Edition. United States Department of Agriculture, Natural Resources Conservation Service, USA Agriculture Handbook No. 436 pp 869.