Contemporary and relict processes in a coastal acid sulfate soil sequence: microscopic features

R. M. Poch[1, 2], B.P. Thomas[1], R.W. Fitzpatrick[1], R.H. Merry[1] and M.D. Raven[1]

[1]CSIRO Land & Water/ University of Adelaide, Private Bag No. 2, Glen Osmond, S.A., 5064
[2]University of Lleida, Catalonia, 25198, Spain

AIMS Develop mechanistic models to illustrate:

- stages in soil profile and horizon evolution at microscopic scale
- chemical, physical and mineralogical processes
- formation and movement of acidity

SOIL PROFILE & HORIZON EVOLUTION

Barker Inlet is a tidal dominated estuary located 20 km north of Adelaide, South Australia. The Gillman area consisted of Histic-Sulfidic Intertidal Hydrosols (Isbell 1996) in tidal mangroves and supratidal samphire with sulfidic material, until the area was drained in 1954 (Figure 1).

In the upper horizons of the drained tidal soil, rapid oxidation of pyrite in organic residues with sulfidic material caused precipitation of iron oxides and lenticular gypsum. Gypsum was subsequently dissolved by leaching. Coatings of jarosite and iron oxides have formed along root channels and pores.

Jarosite is the main weathering product of pyrite oxidation in the underlying back-barrier sand (horizon 4Bg). Soil pH decreases with depth due to decreasing buffering, oxidation of fine pyrite and disseminated jarosite, forming a thick sulfuric horizon that overlays sulfidic material (Figure 2). This profile classifies as a Sulfuric Redoxic Hydrosol (Isbell 1996).

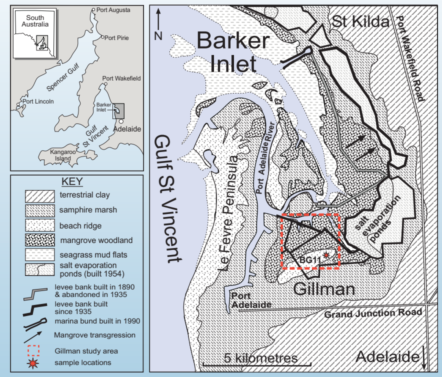
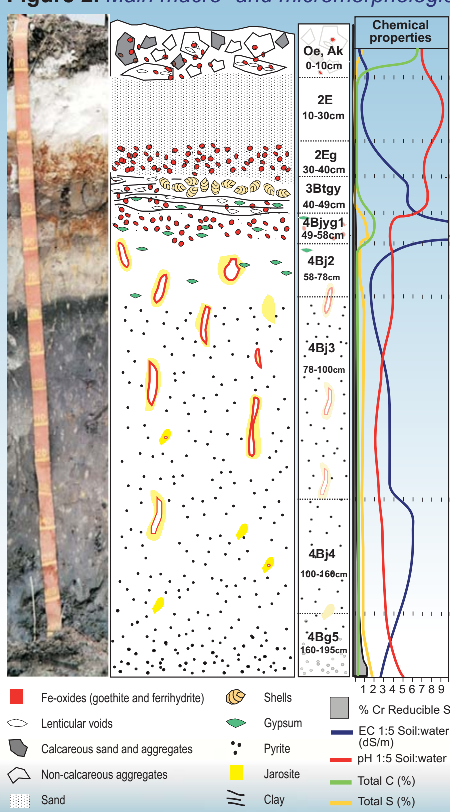


Figure 1. *Barker Inlet is located 20kms north of Adelaide, South Australia. Soil profile BG11 is located at Gillman which was drained in 1954 when a bund wall was constructed to reclaim intertidal mangrove and samphire salt marsh for agriculture and industry.*

Figure 2. *Main macro- and micromorphological features of profile BG11*



Oe, Ak: Crumb structure, calcareous and siliceous, partly layered with lenticular voids, rounded sand-size iron nodules, not related to pores. Ferrihydrite-goethite nodules are pseudomorphs after pyrite framboids.

2E: Quartz sand, very little organic residue. Very fine clay coatings on sands, microlaminated.

2Eg: Sand with strong impregnations of Fe oxides (goethite) associated with blackened organic matter, pseudomorphs after pyrite. Discontinuous shell lenses with gypsum on the shell surface.

3Btgy: Layered clay, with lenticular voids, showing porostriation. Gypsum crystals (pseudohexagonal and lenticular) as infillings and intercalations, granostriated b-fabric. Few jarosite hypocoatings.

4Bjyg1: Sand with gypsum and jarosite hypocoatings around roots, iron coatings and quasicoatings on jarosite. Loose discontinuous infillings of lenticular gypsum, decreasing with depth. Horizontal intercalations of blackened organic matter and black pseudomorphs of pyrite. Coarse lenticular pores.

4Bj2, 4Bj3 and **4Bj4:** Sulfuric horizons and pyrite-containing material. Occasionally jarosite coatings form around large root channels, adjacent to root residues. Hypo- and quasi-coatings of Fe-oxides on jarosite hypocoatings. Few pyrite framboids scattered in the groundmass and with residual organic matter.

4Bg5: Sulfidic material (pyrite framboids).

Figure 2.1. *Thin section analysis of BG11, horizon 2Eg shows a pore (root channel) surrounded by orange Fe oxides. Field of view is 3.2 mm across. Image 1 is PPL, image 2 is XPL and image 3 is reflected light.*

Figure 2.1.1. *Scanning electron micrographs of goethite pseudomorphs replacing pyrite near root channel (BSE).*

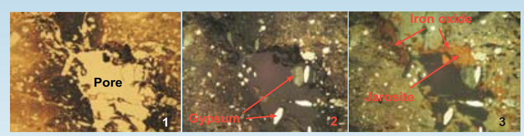


Figure 2.2. *Thin section analysis of BG11, horizon 4Bjyg1 shows a pore with loose discontinuous gypsum infilling and lenticular gypsum crystals, orange Fe coating and yellow jarosite hypocoating. Field of view is 6.5 mm across. Image 1 is PPL, image 2 is XPL and image 3 is reflected light.*

Figure 2.3. *Thin section analysis of BG11, 4Bg5 showing jarosite coating, Fe-hypo and quasicoatings, yellow jarosite hypocoating and pyrite quasicoating around a root channel with organic residues in a quartz sand. There is no gypsum in this sample. Field of view is 4.2 mm across. Image 1 is PPL, image 2 is XPL and image 3 is reflected light.*

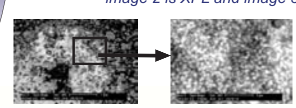


Figure 2.3.1. *Scanning electron micrographs of jarosite pseudomorphs after pyrite. Back scatter electron mode (BSE).*

CONCLUSIONS

Micromorphology identified the following stages in formation and transformation of:

- **Clay layering (3Btgy horizon) by sedimentation rather than clay illuviation.**
- **Gypsum by decalcification of shells and gypsum dissolution to form lenticular pores.**
- **Pyrite associated with organic matter and its transformation to jarosite and goethite.**

Acknowledgements:
We thank the project consortium members: Port Adelaide Enfield City and Salisbury Councils, Torrens and Barossa Catchment Boards, Penrice Soda Products P/L, Land Management Corporation and Natural Heritage Trust for their generous cooperation and financial support. Poster prepared by Brett Thomas, December. 2004.