SOUTHERN CAVER

No. 65

March 2010

In this issue:

Matt Cracknell

on Eddy Creek Karst

Occasional Journal of Southern Tasmanian Caverneers Inc.

PO Box 416 Sandy Bay, Tasmania 7006, Australia ISSN 0157-8464

Editorial

This issue features a modified version of a report prepared in 2008 by Matt Cracknell as part of his studies towards the degree of Bachelor of Science at the University of Tasmania.

The report is largely based on original field work and is intended to document the karst landforms of the Eddy Creek catchment in order to provide land managers with information on which they might base appropriate management prescriptions for the area.

After this report was written in 2008, several changes to the Tasmanian Geoconservation Database (TGD) were made specifically regarding the Eddy Creek karst area. Eddy Creek was originally listed in the TGD as part of a broader area of dolomite refered to as the Glovers Bluff Karst (HUO33). The description stated that the area was of low relief and unlikely to contain explorable caves (TGD version 6.0). An amendment was proposed by Cracknell & Eberhard to the existing listing in light of new information concerning the nature and values of the karst, especially around Eddy Creek. Recommendations included upgrading the site significance to State level, expanding the discussion of values and threats, and renaming the site as the Glovers Bluff-Eddy Creek Karstland. These changes were endorsed by the TGD expert panel in October 2009 and will be given effect in the forthcoming TGD version 7.0.

Greg Middleton, Editor
ozspeleo@iinet.net.au

STC was formed by amalgamation of Tasmanian Caverneering Club, Southern Caving Society and Tasmanian Cave and Karst Research Group in 1999.
STC is the modern variant of the oldest caving club in Australia (TCC, 1946).

Southern Caver

Occasional journal of
Southern Tasmanian Caverneers Inc.

PO Box 416, Sandy Bay,
Tasmania 7006 Australia

www.lmrs.com.au/stc

ISSN 0157-8464

Issue No. 65, March 2010

Contents

Cover photos:
Upper: EC5 doline with drafting entrance
Lower: Main stream passage looking downstream in EC2
Photos: Matt Cracknell

Eddy Creek marble karst

M. Cracknell

Abstract

The Eddy Creek karst is unique in Tasmania having developed within marbleised dolomite. The geological context of this karst area is the primary reason for its listing in the Tasmanian Geoconservation Database (TGD) as a feature that contains significant geoconservation values. However, all identified karst landforms are located within the boundaries of two Mineral Exploration Licences (EL's), permitting exploration for base metals and dolomite/marble construction materials. Prospecting, mining and quarrying operations pose a serious threat to the natural values contained within the Eddy Creek karst area. A lack of adequate information on the true extent of potential karstified bedrock and its hydrological inputs and outputs increases the likelihood of significant impacts occurring to the karst system. This report provides land managers with baseline information on the location and morphology of karst landforms within the Eddy Creek catchment.

Introduction

Karst is characterised by distinctive landform assemblages and complex subsurface hydrological networks (Ford & Williams, 2007) that potentially host a range of significant conservation values (Kiernan, 1988; Watson *et al.*, 1997). Significant conservation values associated with karst landforms do not just include the provision of habitat for unique biological communities (Doran, 2000); they also harbour rare elements of abiotic nature (Dixon, 1991; Sharples, 2002; Gray, 2004; Ford & Williams, 2007). Geoconservation primarily focuses on the protection and preservation of significant elements of abiotic natural diversity, otherwise known as geodiversity (Sharples, 2002; Gray, 2004). Geodiversity encompasses geological (bedrock), geomorphological (landforms) and pedological (soil) features and processes. Insufficient information on the true extent of surface and subsurface karst landforms and their hydrological connectivity has implications for the effective management and protection of significant geoconservation values (Kiernan, 1988; Watson *et al.*, 1997; Kiernan, 2002; Sharples, 2002; Gray, 2004).

The Tasmanian Geoconservation Database (TGD) contains the locations of, and information on sites and features recognised as containing significant geoconservation values. The TGD is a management tool, developed to assist the protection and preservation of Tasmania's geodiversity (Eberhard & Hammond, 2007). Within the Eddy Creek catchment several sites and features appear in the TGD (theLIST, 2007a) including; karst landforms developed within marble, and a geological feature known as the Glovers Bluff Inlier. The presence of karst hosted in marble is significant (Kiernan, 1995). It is possibly the only location in Tasmania where considerable karst development occurs within marble.

Land use within the Eddy Creek catchment that poses a risk, directly or indirectly to the geoconservation values associated with the Eddy Creek marble karst include forest harvesting, road construction, mineral exploration, mining and quarrying activities. Documenting karst landforms, their locations and spatial relationships play a vital role in reducing the impacts of land use on karst systems (Kiernan, 1988; Kiernan, 2002; Sharples, 2002). This report aims to document karst landforms found within the Eddy Creek catchment, thus providing land managers with information for the development of appropriate management prescriptions within the Eddy Creek area.

Study Site

The Eddy Creek karst was originally named the Glovers Bluff karst by Sharples (1994) and Kiernan (1995). This nomenclature was relevant at the time, as potential karstic bedrock had been mapped south of the Weld River at Glovers Bluff extending to the north of the Weld River to Eddy Creek (Calver, 1999). Although defining karst boundaries is in some cases never certain (Kiernan, 2002) there is no evidence of karstic hydrological connections between the northern (Eddy Creek) and southern (Glovers Bluff) catchments of the Weld River (Duhig, 2005). Therefore, both Duhig (2005) and Cracknell (2007) have assigned the name of Eddy Creek to the karst area detailed in this report.

Eddy Creek is a small tributary to the Weld River, situated approximately 4 km north-west of the Huon/Weld River confluence in Southern Tasmania. The Eddy Creek catchment originates on the southeastern flank of the Snowy Range, within 1.5 km of the Southwest National Park boundary (TASMAP, 1987). The eastern slopes of this valley, a State Forest reserve, contain a poorly documented area of dolomite/marble hosted karst landforms (Figure 1) (Sharples, 1994; Kiernan, 1995; Duhig, 2005). Recent reconnaissance mapping of this karst area had discovered one doline, several springs and three vertical cave entrances (Duhig, 2005; Cracknell, 2007).

Methods

Field observations in the Eddy Creek catchment were carried out over four days in late March 2008. The ~1 km^2 target area for this study was defined using a geological map (Calver, 1999) and personal notes (Cracknell, 2007) Observations including detailed cave surveys, geomorphological and hydrological observations, and structural geological measurements were collected. Field site and karst feature locations were recorded using a handheld Garmin12 Global Positioning System (GPS) receiver. Cave surveys were conducted using a fibreglass tape measure, Suunto sighting compass and clinometer. Caves were surveyed to ASF Grade 44 (Anderson and others, 1978) and survey data was corrected for magnetic declination (defined as 14.2° east of grid north (Geoscience Australia, 2005)).

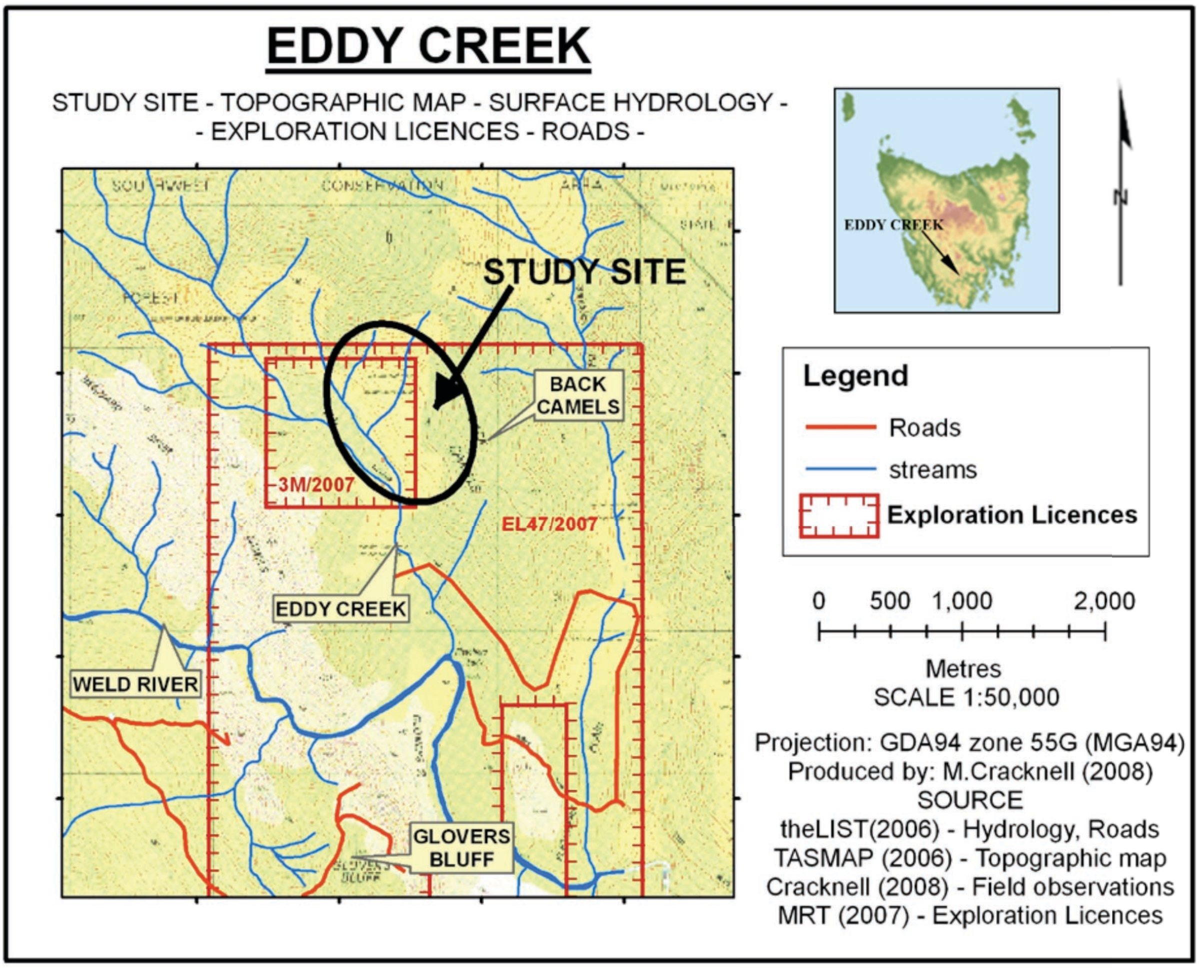


Figure 1. Eddy Creek location map, major topographic features and Exploration Licences

The Geographic Information System (GIS) software package ArcGIS 9 was used to: digitise features identified from field observations and sourced datasets; compile and display field data; create maps; and build databases with appropriate metadata references. In addition, the following spatial data was utilised from the Land Information System Tasmania (theLIST, 2006) and TASMAP (2006):

- theLIST transport segment (roads)
- 10 m contour lines

- Watercourse 1D and 2D
- Digital Elevation Model (DEM) (12.5 m grid)

Scanned 1:25,000 Weld geology (Calver, 1999) and bedrock geology (Calver, Forsyth & Everard, 2006 Figure 6, p. 32 and Figure 7, p. 34 modified from Carthew *et al.*, 1988; Young, 1997; Summons, 1999) maps were used to digitise bedrock and surface deposit boundaries and lithologies. Georeferenced geology maps provided a reference layer to build a polygon shapefile (SHP) of geological units. In addition, a separate polyline SHP of the geological contacts/boundaries was generated. Associated attributes of both the geology and surface deposits datasets include information such as lithology (dolerite, dolomite, etc.), contact type (conformity, fault, etc.), the level of certainty of the contact location (mapped, inferred, etc.) and source.

A surface karst features point SHP and surface hydrology features polyline SHP were created using GPS coordinates and field notes. Karst features have been given unique identifier codes (i.e. EC1, EC2, EC3 etc.) and elevation data for each point was obtained from the 12.5 m DEM dataset. Attributes within the hydrology feature SHP are designed to provide information on whether the feature is permanent, intermittent or possibly concealed beneath surface deposits. Exploration Licence (EL) boundaries are defined in a polygon SHP File from information supplied by MRT (2007).

Results

Geology

The majority of subsurface karst landforms have formed in marbleised and partially silicified Neoproterozoic dolomite bedrock (Figure 2). This marble bedrock unit corresponds to the skarn – altered dolostone (dolomite) unit described in Calver (1999). Bedding in the dolomite strikes ~320° and dips subvertically to the NE (facing unknown) at a location ~ 1 km west of the study site (Calver, 1999). The marble and other pre-Carboniferous units in the Eddy Creek area form part of the Glovers Bluff Inlier (Sharples, 1994; Calver, Forsyth & Everard, 2006). This geological feature is an unusual juxtaposition of pre-Carboniferous (Proterozoic-Cambrian?) age bedrock units (including dolomite) surrounded by post-Carboniferous (Permian-Jurassic-Tertiary?) age rocks. The Glovers Bluff Inlier is believed to be a rafted block of pre-Carboniferous basement rocks overlying a Jurassic dolerite feeder structure. The unusually large heat flux focus from the dolerite feeder(s) below the dolomite is thought to be related to the marbleisation and silicification of the karst host rocks within the Eddy Creek catchment (Calver, Forsyth & Everard, 2006).

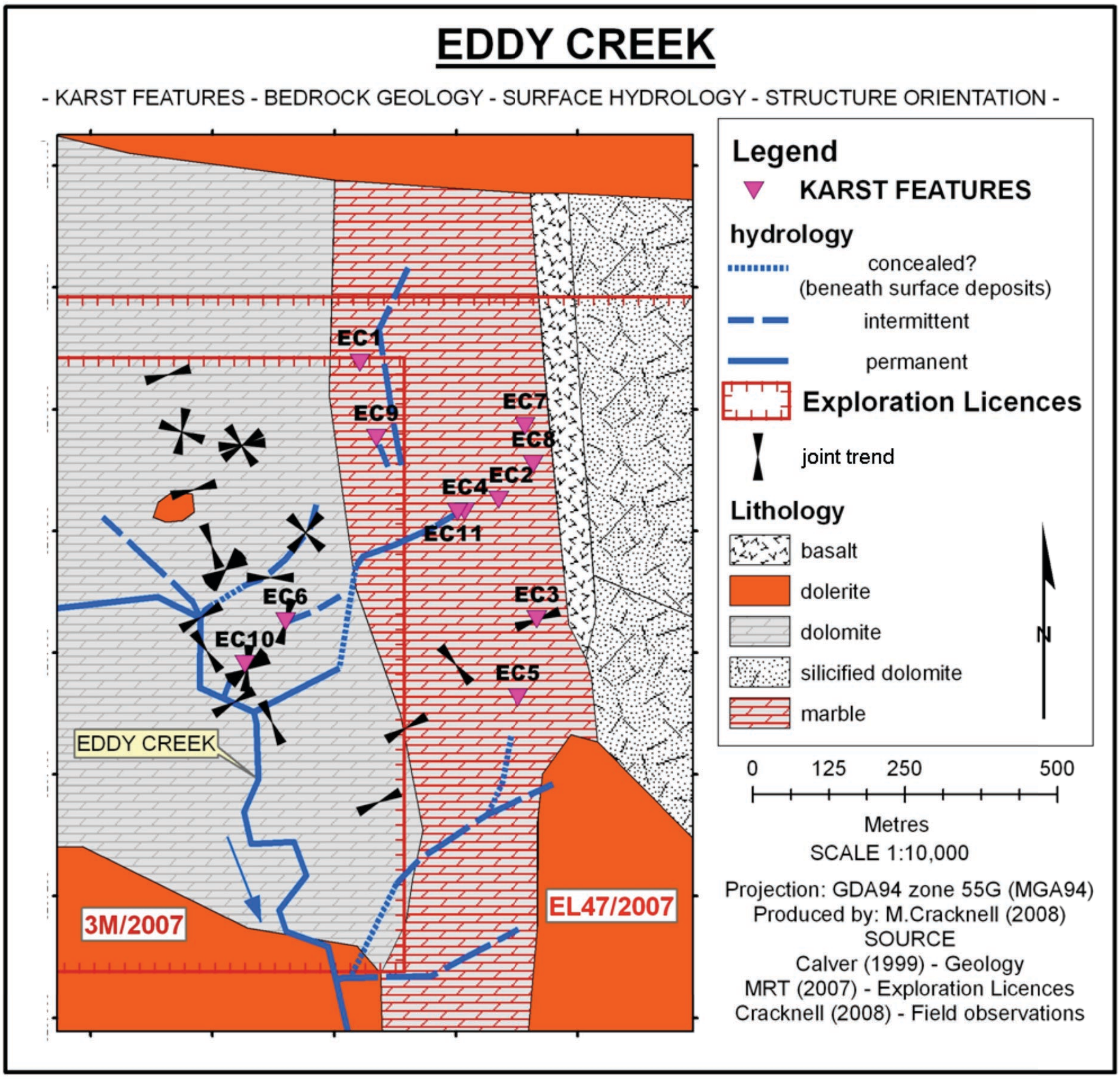


Figure 2. Eddy Creek karst features, bedrock geology and Exploration Licences – includes joint trends

Basic geological field observations, and the position of karst features indicate that the boundaries of the dolomite and marble bedrock units have most likely been positioned incorrectly in Calver (1999) and Calver, Forsyth & Everard (2006 Figure 6, p. 32, modified from Carthew *et al.*, 1988; Young, 1997; Summons, 1999). As a result, the marble contact to the east has been redrawn 100 m west of, and the inferred northern dolomite/marble boundary redrawn 290 m north of the positions interpreted in the above sources.

Landforms and surface deposits

Field observations suggest that epikarst, a weathered zone of carbonate bedrock near the surface, is well developed in the Eddy Creek karst. Epikarst is the principle means by which recharge is transmitted to the water table in karst areas. Transmission through the epikarst is dependent on the connectivity, density and contents (e.g. soil) of fractures and fissures present within bedrock (Ford & Williams, 2007). In this case, organic matter, soil and colluvium ubiquitously fill surface fractures in the dolomite/marble bedrock (Figure 3) providing rapid transmission of water into the underlying karst.

Figure 3. Organic matter, soil and colluvium filling epikarst exposure near the entrance to EC6 (notebook is 15 cm long)

Depressions and dry gullies within the study area contain thick organic material and soil. The only flowing stream observed during the field work period within the study area emerged from thick regolith ~50 m west of EC11, although no water was seen emerging from this feature. The stream disappeared and reappeared several times under thick regolith before flowing down the lower slope of the eastern flank of the valley. However, this connection has not been confirmed.

To the north and south of the study area, dolerite slope deposits (talus) mantle carbonate bedrock. These slope deposits are predominantly composed of clast supported, angular to subangular dolerite boulders with weathering rinds of >1 cm and covered by imperfectly drained dolerite derived soils (Figure 4) (McIntosh, 2005). In contrast, soils developed on exposed silicified dolomite bedrock are characterised by thin soils with well drained sand and coarse cherty gravel profiles (McIntosh, 2006). Both these soil types have been recognised as having moderate to high erodability on steep slopes, and thus fall under the definition of Vulnerable Karst Soils (*Forest Practices Code,* 2000 in Duhig, 2005; McIntosh, 2005). An absence of direct hydrological inputs in the exposed area of carbonate rock suggests the karst

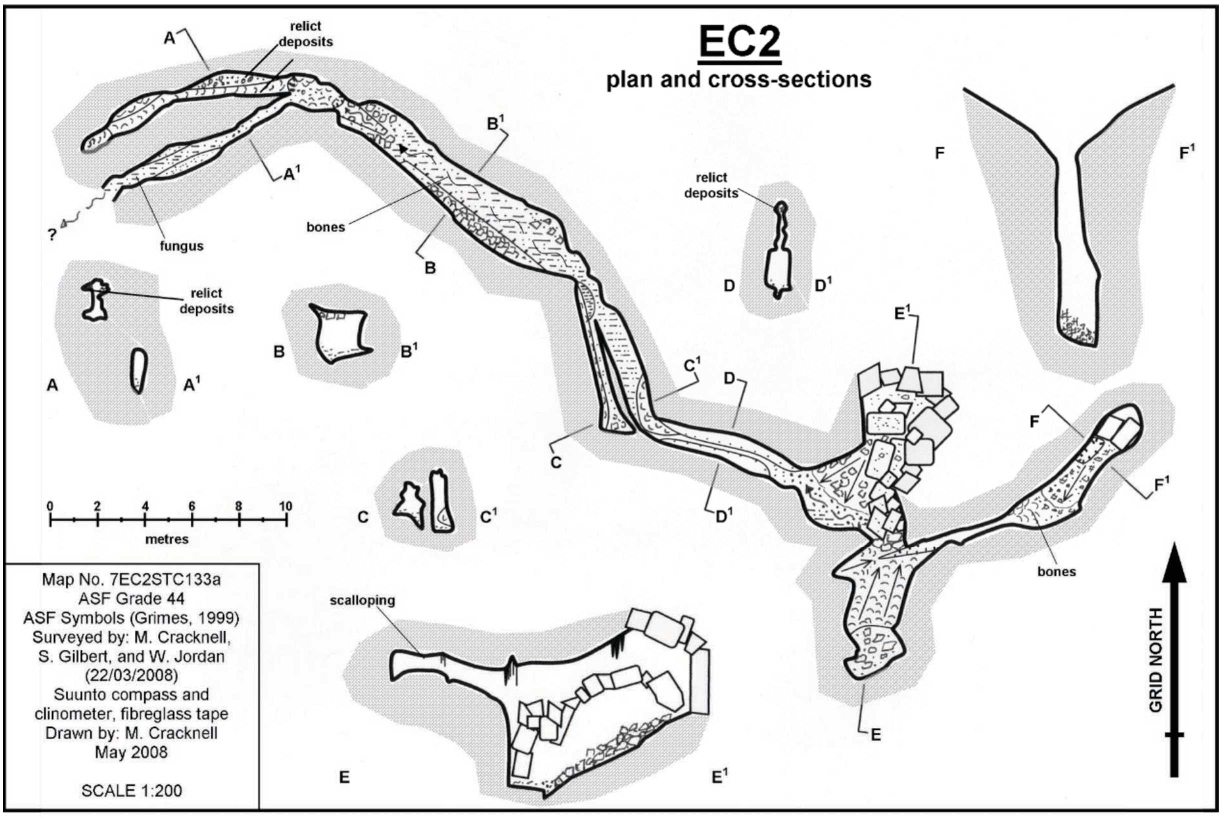
Figure 4. Dolerite derived Vulnerable Karst Soils on dolomite/marble bedrock

drainage system is fed via diffuse seepage through dolerite talus slope deposits (Kiernan, 2002; Laffan & McIntosh, 2005).

Karst features

A total of five caves, three dolines and three springs have been identified in the study area to date. All identified karst features lie within the boundaries of the EL47/2007, while two caves (EC1 and EC6) and two springs (EC9 and EC10) lie within the boundaries of 3M/2007 (see Figure 2).

The largest cave explored and surveyed within the Eddy Creek karst area is EC2 (Figure 5). EC2 is ~80 m in surveyed length and reaches a depth of ~20 m below the base of the entrance doline. EC2 features a "pothole" type vertical entrance 8 m in depth. Within the entrance chamber are several large intermittently active stalactites and walls covered in flowstone. Beyond the entrance is a breakdown chamber with numerous slabs of marbleised dolomite concealing an intermittently active stream.



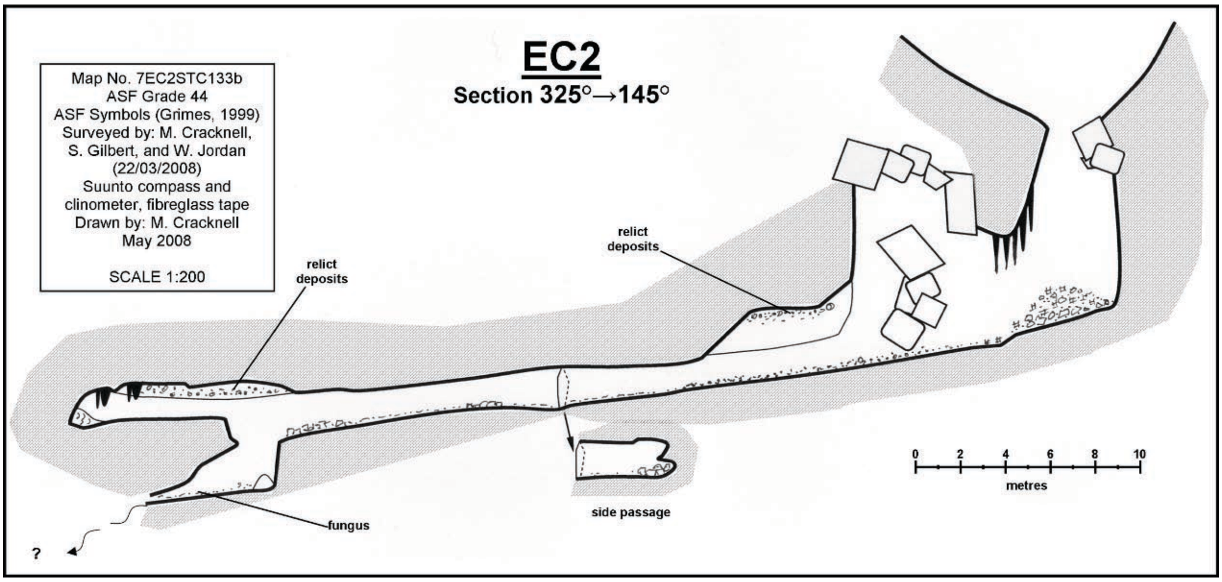


Figure 5. EC2 maps – plan, cross-sections, and profile (original scale 1:200)

At the time of surveying there was no water in the stream channel. However, evidence that it carries low discharge water flow was found in the form of gravel and mud banks associated with small incised channels (~20 cm wide). A linear passage, generally orientated NNW, floored by very angular marbleised dolomite blocks (Figure 6a) reaches a nick point ~3 m high where the intermittently active stream channel abandons the main passage. The abandoned upper level, at the same height as the passage upstream, contains masses of flowstone/stalactites and relict sedimentary deposits perched on ledges ~4 m above the present level of the stream channel. These deposits are comprised of poorly sorted subangular to rounded pebbles, cobbles and boulders in a clay matrix (Figure 10). The composition of clasts appeared to be of pinkish silicified dolomite and basalt. No dolerite clasts were seen. The intermittently active stream channel continues beyond the limits of accessible cave in EC2. Further investigations are needed to confirm downstream hydrological connections.

EC3 is a small vertical cave with a steeply descending ramp that opens into a small chamber (Figure 7). The floor of this cave is littered with organic debris and marble clasts (<10 cm Ø). The morphology of EC3 suggests it has developed as a result of breakdown collapse into voids below. To the south of EC3 is the large doline EC5. EC5 is approximately 30 m in diameter and 8 m deep making it the largest surface feature discovered in the area thus far.

EC4 is a small horizontal cave located in the drainage depression directly west of EC2 (Figure 8). EC4 contains an intermittently active stream channel and soft black wall coatings. Water inflow and outflow for this cave appears to be from diffuse seepage. West of EC4 is a small intermittently active spring (EC11) fed by water seeping out from between the marble bedrock/soil contact. EC4 and EC11 are interpreted to be hydrologically linked.

Figure 6. EC2 a) main passage (~2 m high) in EC2 looking downstream, the ceiling has developed along marble bedrock and the floor contains an intermittent stream channel, and b) relict sedimentary deposits perched on a ledge in the abandoned upper level of EC2.

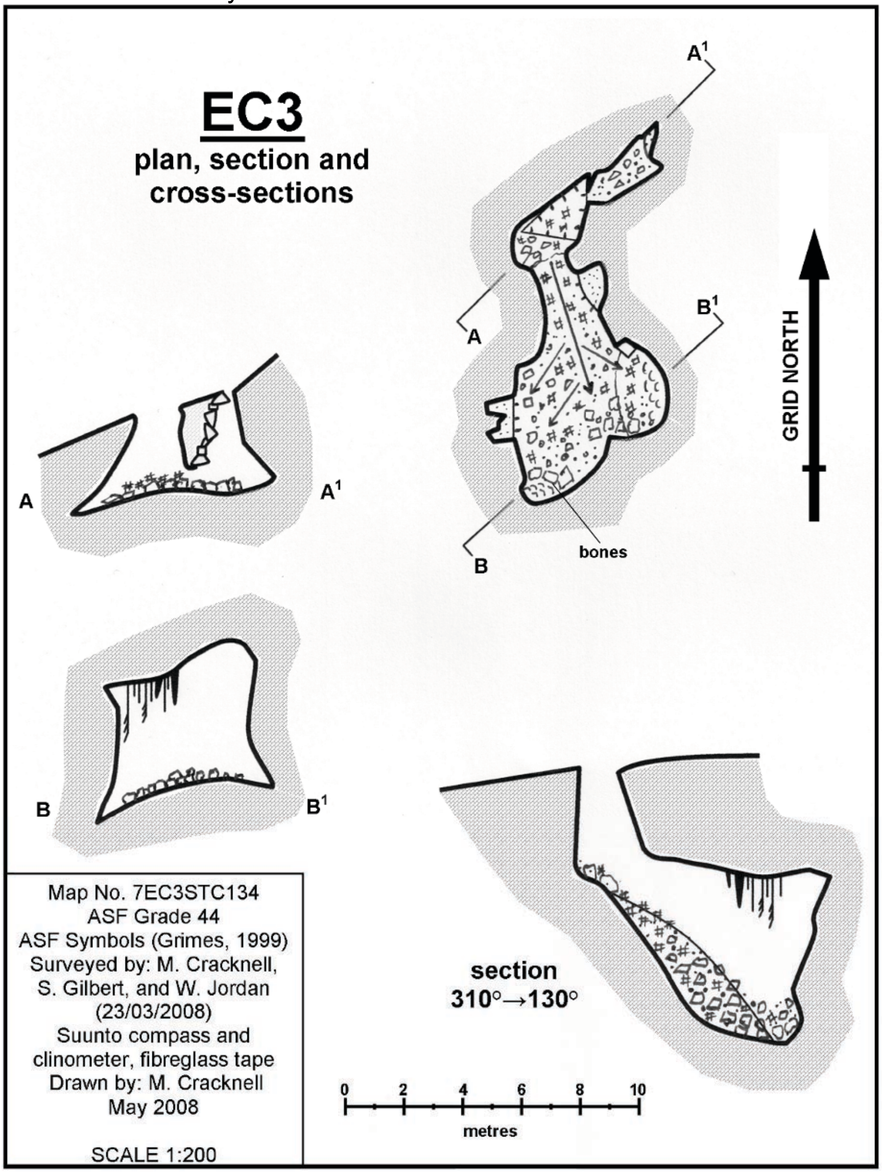


Figure 7. EC3 plan, cross-sections and section 310° - 130° (original scale 1:200)

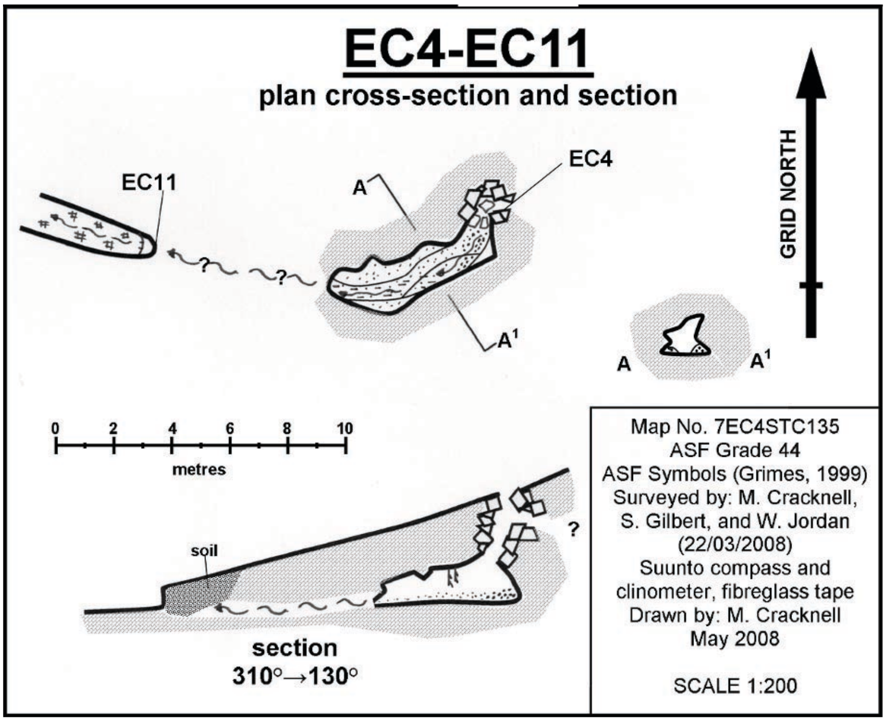


Figure 8. EC4 and EC11 plan, cross-section and section 310° - 130 (original scale 1:200)

Uphill from EC2, EC4 and EC11 are two dolines (EC7 and EC8), both filled by organic matter and dark brown soils. EC7 is approximately 20 m in diameter west to east, although its northern limit continues uphill without an obvious break in slope. EC8 is 20 m above and 80 m NE of EC2, situated at the base of a hillslope in a shallow depression. A small drafting opening was observed within EC8.

EC6 (Figure 9) and EC10 are found adjacent to a dolomite scarp that runs along the edge of the Eddy Creek valley floor. EC6 has developed in a narrow fissure at the bottom of a dry gully. The morphology and deposits (large angular boulders of dolomite) within this gully are characteristic of an ephemeral stream. EC6 contains washed angular to subangular coarse

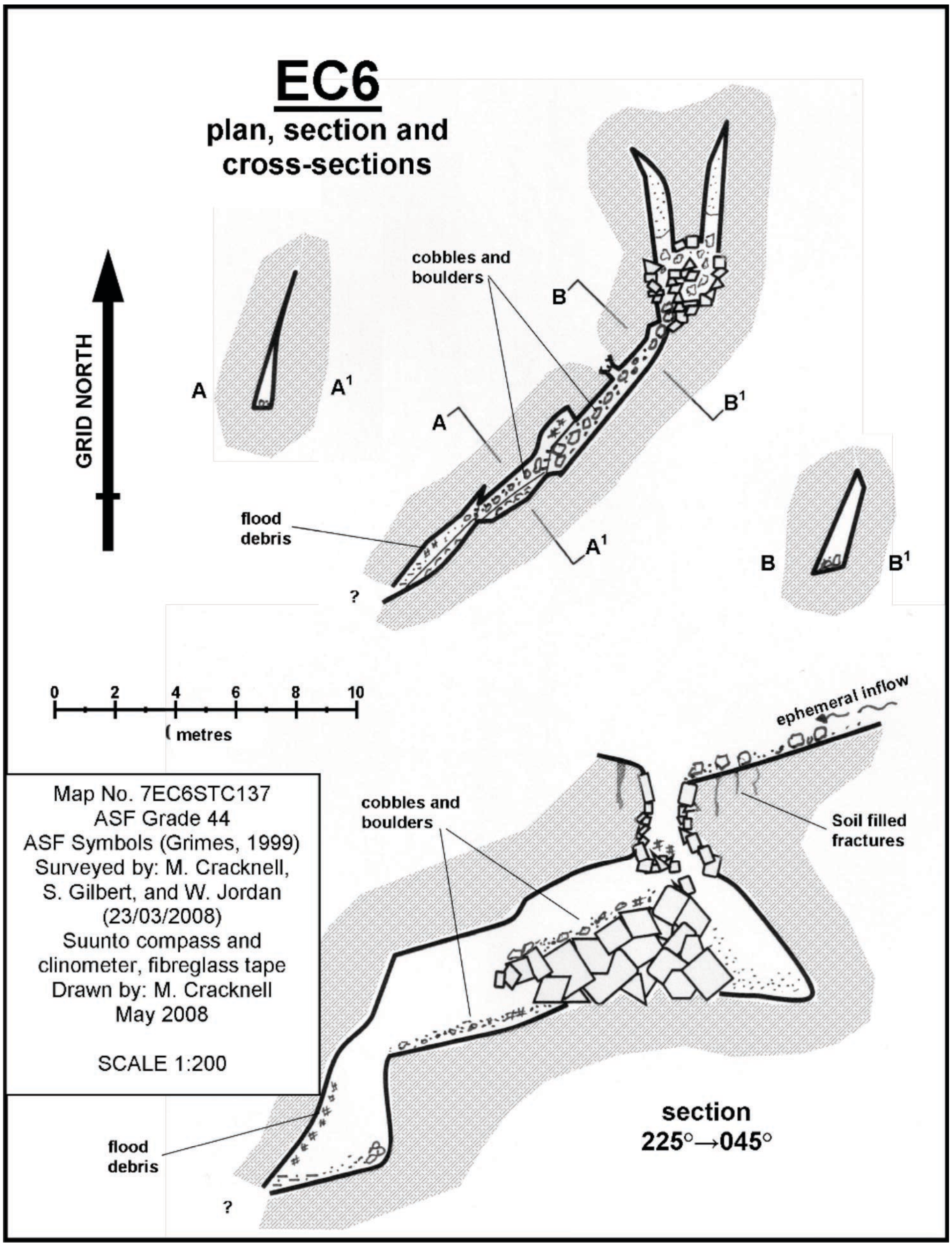


Figure 9. EC6 plan, cross-sections and section 225° - 045° (original scale 1:200)

gravels, pebbles and cobbles, composed primarily of silicified dolomite and marbleised dolomite. Flood debris coats the walls in the lower reach of EC6 suggesting that it back-fills during high water flow. EC6 is orientated SW toward a spring (EC10) less than 100 m away. EC10 was not active at the time of observation. However, thin tufa like coatings on the bare dolomite surfaces (Figures 10a and 10b) suggest that carbonate rich waters flow from this feature during wet periods.

Figure 10. EC10 a) spring and b) close up of tufa coatings

During the field work period the only karst feature to exhibit evidence of recent water flow was the spring EC9 where a trickle of water was flowing out of one of two small entrances (too small to gain access). In addition, at the constricted openings to EC9, a cool draft flowing out of the entrances was detected. This air movement suggests that EC9 is connected to a more substantial subsurface drainage system, probably linked to the cave EC1 (see discussion on cave passage orientations below). EC1 is a small vertical cave developed along a narrow fissure (Figure 11), located 35 m higher and ~130 m NNW of EC9.

Geological structures

The rose diagram in Figure 12a presents measured joint orientations as a percentage of total measurements. Figure 12b presents cave passage orientations as a percentage of the total survey distance for all caves. There is evidence for structural influence on cave development orientated 240°-60° and 340°-160°. From the limited information in Calver (1999) this orientation does not closely correspond to the strike of bedding in the dolomite/marble bedrock (i.e. ~320°). It is possible that a large proportion of cave passage orientations are related to jointing and other structural weaknesses such as faults (Summons, 1999). This combined with hydrothermal fluid movement, may have resulted in compositional and hence solubility contrasts within the metamorphosed carbonate bedrock (Calver, Forsyth & Everard, 2006).

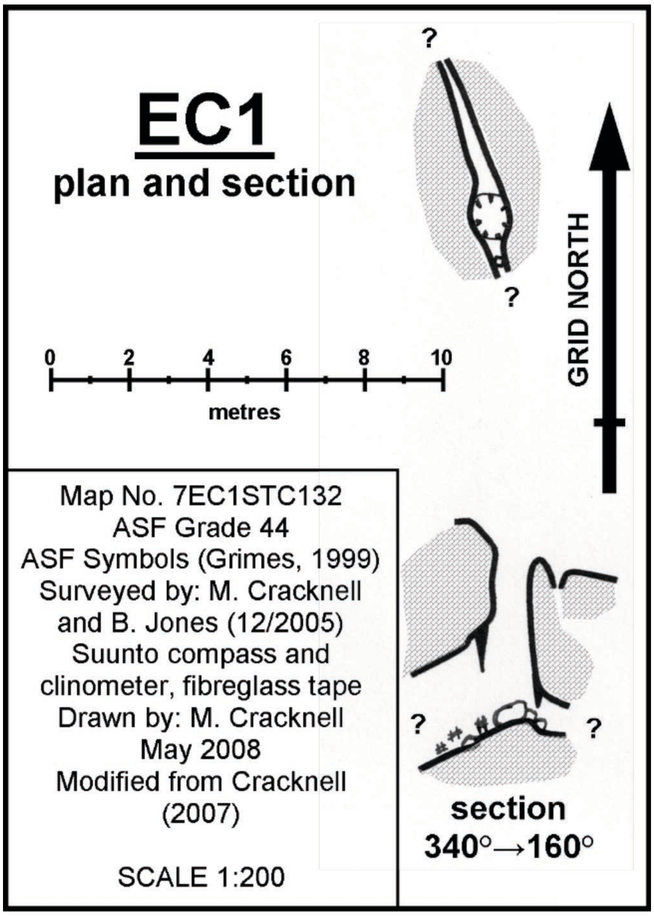


Figure 11. EC1 plan and section 340° - 160° (original scale 1:200)

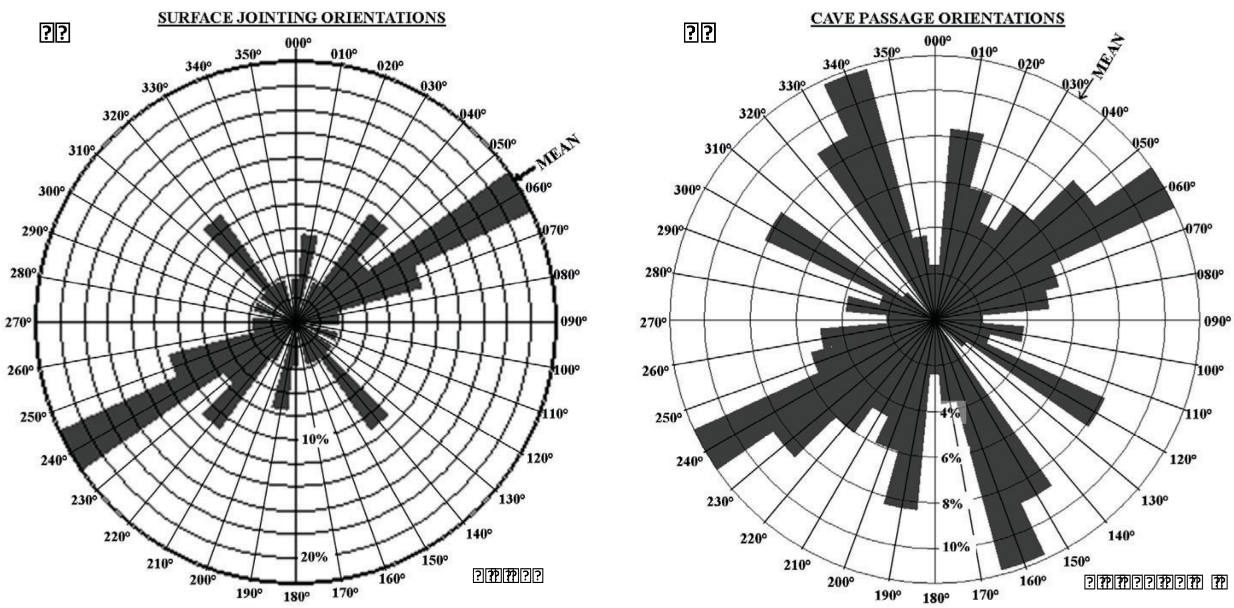


Figure 12. Frequency rose diagrams for a) surface outcrop joint orientations and b) cave passage orientation

Discussion

A range of karst landforms including relict and active subsurface hydrological systems have been identified within the Eddy Creek catchment. The karst in this area is known to be hosted by marbleised dolomite bedrock (Calver, Forsyth & Everard, 2006), a rare and possibly unique occurrence in Tasmania (Sharples, 1994; Kiernan, 1995). The well developed epikarst noted during field observations suggest that while there is a low density of surface karst features in most of the investigated carbonate bedrock areas, it is highly likely that there are numerous smaller hydrological connections to undiscovered karst drainage systems (Ford & Williams, 2007).

The Eddy Creek karst area has been recognised by conservation management authorities and is listed as a feature of geoconservation significance in the TGD (called the Glovers Bluff Karst (Sharples, 1994; Kiernan, 1995; theLIST, 2007a). The TGD describes the Eddy Creek karst as having an unknown significance. However, based upon the composition of the host bedrock there is enough evidence to give this karst area a state (Tasmanian) level of significance.

In the TGD, the Eddy Creek karst has been assigned a sensitivity rating of 4 (theLIST, 2007a). The TGD sensitivity ratings are based on work by Kiernan (1997b in Gray, 2004 table 4.4, p. 172), where 4 is described as,

> *"Values sensitive to damage by remote processes – degradation of geomorphic soil processes by hydrological or water quality changes associated with the clearing or disturbance of catchment, fractures/vibration due to blasting in adjacent areas (e.g. to stalactites in caves); karst sites susceptible to damage if subsurface seepage water routes change due to creation of new fractures."*

According to Eberhard & Hammond (2007) the TGD sensitivity rating implies an 'overall vulnerability' of the geoconservation values within a listed area. They go on to stress that sensitivity is non-uniform and may vary considerably. This is particularly true in karst areas where sensitivity is dependent upon the level of karstification, potential for systematic links within the karst system, and assumptions on the probable impacts of karst values from forest harvesting, associated activities and other land use practices (Eberhard, 1998; Eberhard & Hammond, 2007). Based on the findings presented in this report, a change to the overall sensitivity rating of the Eddy Creek karst should be reviewed.

The Glovers Bluff Inlier is a significant geoconservation feature (Sharples, 1994; Calver, Forsyth & Everard, 2006) with a sensitivity rating of 8 (theLIST, 2007a). It is therefore less sensitive to moderate human impacts than the Eddy Creek karst. Nevertheless, mining and quarrying activities pose a significant threat (Gray, 2004).

To their credit, Forestry Tasmania's (FT) land managers are aware of some of the geoconservation issues in the Eddy Creek catchment. Forest Practices Authority geoscientists are advising FT on appropriate land use practices in the vicinity of the known limits of the Eddy Creek karst and Glovers Bluff Inlier (Duhig, 2005; McIntosh, 2005; Hammond, 2008; Ware, 2008). However, indirect consequences of forestry operations such as regeneration burns that "escape" into neighbouring forest or inappropriate road design can have an impact on water quality, drainage networks and soil stability in karst areas (Kiernan, 2002; Ford & Williams, 2007). These potential impacts in conjunction with cave

Minerals exploration and mining operations within the Eddy Creek Karst have the potential to cause serious negative impacts to significant geoconservation values. The current EL's, EL47/2007 and 3M/2007 have been granted to prospect for gold, zinc, nickel, and Platinum Group Metals and dolomite/marble construction materials respectively (Summons, 1999; Calver, Forsyth & Everard, 2007; MRT, 2007). Both EL's coincide with karst landforms identified in this report. Exploration activities have the potential to seriously impact on karst drainage systems and water quality due to the construction of roads, the use of toxic substances and drilling operations (Kiernan, 1988; Kiernan, 2002; Ford & Williams, 2007). Exploration also implies that if economically viable resources are discovered mines and quarries will be established. Operations of this kind present the most extreme case of impacts to karst features and hydrology, directly resulting from drilling/blasting, removal of large volumes of rock, construction of substantial infrastructure and the effects of acid mine drainage (Gurung, 2002; Kiernan, 2002; Ford & Williams, 2007).

Conclusion

The Eddy Creek catchment has been shown to contain a greater degree of karst development than previously anticipated. Even so, a relatively small proportion of the potential extent of karst in the area has been explored and documented to date. The locations and important features of the known karst landforms within the Eddy Creek catchment are documented in this report. Significant geoconservation values associated with the Eddy Creek karst include marbleised dolomite hosted karst landforms, and geological links to the Glovers Bluff Inlier.

A wide range of human activities have the potential to negatively affect the karst drainage system within in the Eddy Creek catchment. Forestry operations, mineral exploration and possible future mining operations in the vicinity of the Eddy Creek karst will threaten the geoconservation values it is known to contain (Kiernan, 1988; Watson *et al.*, 1997; Kiernan, 2002; Ford & Williams, 2007). In order to effectively mitigate and manage negative impacts to karst systems, adequate and accurate information on their location and physical characteristics must be collected and thoroughly assessed (Kiernan, 1988; Watson *et al.*, 1997; Kiernan, 2002; Sharples, 2002; Gray, 2004). Several key issues present serious hurdles for developing effective karst management plans in the Eddy Creek catchment. These issues include a poor understanding of the true extent of carbonate bedrock concealed beneath surface deposits; lack of any obvious stream sinks near the northern and eastern boundaries of the known karst; and limited hydrological connections confirmed between known karst features.

Acknowledgements

This project stemmed from several days of tortuous bush bashing with various people aligned to the Huon Valley Environment Centre during the summer of 2005-2006; thank you Dawn, Brett and Briony. I am also grateful for the guidance, optimism and encouragement offered from Dr Kevin Kiernan, academic supervisor to this project. Thanks must go to The Tasmanian Greens for obtaining material from Forestry Tasmania under the *Freedom of Information Act 1991*, portions of which were directly related to the Eddy Creek Karst area. Most of all I would like to thank my field volunteers, Sarah Gilbert and Warrick Jordan for their patience, assistance and valuable input. Without their help this project would not have occurred.

References

ANDERSON, E. G. and others 1978 ASF Cave Survey and Map Standards <http://www.caves.org.au/m_stdsurv.html>.

CALVER, C. R. 1999 *Weld, Tasmania, Digital Geological Atlas 1:25,000 Series, Sheet 4623*. Tasmanian Geological Survey, Data Management Group, Mineral Resources Tasmania: Hobart, Tasmania.

CALVER, C. R., FORSYTH, S. M. & EVERARD, J. L. 2006 *Geology of the Maydena, Skeleton, Nevada, Weld and Picton 1:25 000 scale map sheets*. Mineral Resources Tasmania: Rosny Park, Tasmania, Tasmanian Geological Survey, Record 2006/04, p. 126.

CALVER, C. R., FORSYTH, S. M. & EVERARD, J. L. 2007 *Explanatory Report for the Maydena, Skeleton, Nevada, Weld and Picton geological map sheets*. Mineral Resources Tasmania: Rosny Park, Tasmania, p. 32.

CRACKNELL, M. 2007 Reconnaissance mapping of the Eddy Creek karst system in the Lower Weld Valley, Tasmania. *Speleo Spiel*, 358: 15-18.

DIXON, G. 1991 Earth resources of the Tasmanian Wilderness World Heritage Area: A preliminary inventory of geological, geomorphological and soil features. *Department of Parks, Wildlife and Heritage Occasional Paper,* No. 25, Hobart, Tasmania (Series Editor G. J. Middleton) p. 63.

DORAN, N. 2000 Getting deep: cave fauna values and conservation. *Forest Practices News*, 3 (1): 5-8.

DUHIG, N. 2005 Email to Terrance Ware-Subject: FW: Eddy Creek Karst (01/12/2005), obtained from Forestry Tasmania by the Tasmanian Greens (released under the *Freedom of Information Act 1991).*

EBERHARD, R. 1998 Planning for karst management in multiple-use forest: The Junee-Florentine karst study. *Tasforests*, 10: 33-47.

EBERHARD, R. & HAMMOND, A. 2007 Rocks and hard places: the Tasmanian Geoconservation Database. *Forest Practices News*, 8 (2): 4-6.

FORD, D. & WILLIAMS, P. 2007 *Karst hydrogeology and geomorphology (second edition)*, John Wiley & Sons, Ltd.: West Sussex, England, p. 562.

GEOSCIENCE AUSTRALIA 2005 *Australian Geomagnetic Reference Field Values*, web site, <http://www.ga.gov.au/oracle/geomag/agrfform.jsp>, last updated 28/06/2005, accessed 12/04/2008.

GRAY, M. 2004 *Geodiversity, valuing and conserving abiotic nature*. John Wiley & Sons: West Sussex, England, p. 434.

GURUNG, S. 2002 Tasmanian Acid Drainage Reconnaissance: Report 1 - Acid drainage from abandoned mines in Tasmania, Mineral Resources Tasmania, National Heritage Trust. *Tasmanian Geological Survey Record* 2001/05, p. 28.

HAMMOND, A. 2008 Email to Terrance Ware-Subject: BB018A (29/02/08), obtained from Forestry Tasmania by the Tasmanian Greens (released under the *Freedom of Information Act 1991*).

KIERNAN, K. 1988 *The Management of Soluble Rock Landscapes: an Australian perspective*. Department of Geography University of Tasmania; reprinted (2002) by The Speleological Research Council Ltd.: Sydney, Australia, p. 62.

KIERNAN, K. 1995 *An Atlas of Tasmanian Karst: Volume Two*, Tasmania Forest Research Council: Hobart, Tasmania, Report No. 10, pp. 134 and 297.

KIERNAN, K. 2002 *Forest Sinkhole Manual*, Forest Practices Board: Hobart, Tasmania, p.35.

LAFFAN, M. D. & MCINTOSH, P. D. 2005 Forest soils formed in Jurassic dolerite in Tasmania: a summary of their properties, distribution and management requirements. *Division of Forest Research and Development, Technical Report* 25/2005, Forestry Tasmania, Hobart, Tasmania, p. 33, <http://www.fpa.tas.gov.au/fileadmin/user_upload/PDFs/Geo_Soil_Water/DoleriteSoilsOverview.pdf>.

LAND INFORMATION SYSTEM TASMANIA (cited as theLIST) 2006 *Vector Data*, Information & Land Services Division, DPIWE, obtained via Data Licensing Agreement, Copyright THE STATE OF TASMANIA.

LAND INFORMATION SYSTEM TASMANIA (cited as theLIST) 2007a *Topographic Maps: Natural Values Atlas overlay (includes dataset from the Tasmanian Geoconservation Database)*, Information and Land Services Division, DPIWE, Hobart, Tasmania, web site, <http://www.thelist.tas.gov.au/listmap/listmap.jsp?cookieteststate=check&llx=47544

6.035&lly=5235971.357&urx=477851.937&ury=5240188.595&layers=4,10,19,20,23,24,26,27,28,30>, last updated 03/07/2007, accessed 13/05/2008.

LAND INFORMATION SYSTEM TASMANIA (cited as theLIST) 2007b *Topographic Maps: Public Land Classification overlay*, Information and Land Services Division, DPIWE, Hobart, Tasmania, web site, <http://www.thelist.tas.gov.au/listmap/listmap.jsp?cookieteststate=check&llx=475446.035&lly=5235971.357&urx=477851.937&ury=5240188.595&layers=4,10,19,20,23,24,26,27,28,30>, last updated 03/07/2007, accessed 13/05/2008.

MCINTOSH, P. 2005 Email to Terrance Ware-Subject: RE: Barnback roadline (18/03/05), obtained from Forestry Tasmania by the Tasmanian Greens (released under the *Freedom of Information Act 1991*).

MCINTOSH, P. 2006 Email to Terrance Ware-Subject: BB021C – reply to notification (13/01/06), obtained from Forestry Tasmania by the Tasmanian Greens (released under the *Freedom of Information Act 1991*).

MINERAL RESOURCES TASMANIA (cited as MRT) 2007 *Licence Details*, Department of Infrastructure, Energy and Resources, State Government of Tasmania, website, <http://www.mrt.tas.gov.au/portal/page?_pagid=35.832420&_dad=portal&_schema=PORTAL>, last updated 03/07/2007, accessed 04/05/2008.

SHARPLES, C. 1994 *Landforms and Geological Sites of Geoconservation Significance in the Huon Forest District (volume two) – Description*. A report to Forestry Commission Tasmania, Hobart, Tasmania, p. 45-47.

SHARPLES, C. 2002 *Concepts and Principles of Geoconservation: Version 3*. Tasmanian Parks & Wildlife Service, Department of Environment, Parks, Heritage and the Arts, Hobart, Tasmania, p. 79, website, <http://www.parks.tas.gov.au/geo/conprin/direct.html>, last updated 29/03/2007, accessed 24/05/2007.

SUMMONS, T. G. 1999 *Annual Report for the Forster Project- RL 9803, EL's 3/94 & 33/96, Southern Tasmania*, Northwest Bay Co. Pty. Ltd. & Sedimentary Holdings Ltd., Mineral Resources Tasmania Report No. 99_4409, <http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/99_4409/>, last updated, 05/03/2005, accessed 16/03/2008.

TASMAP 1987 *Weld Sheet: 4623 (edition one) 1:25,000 Series,* Mapping Division, Department of Lands, Parks and Wildlife, Hobart, Tasmania.

TASMAP 2006 Raster Data, Information & Land Services Division, DPIWE, Hobart, Tasmania, obtained via Data Licensing Agreement, Copyright State of Tasmania.

WARE, T. 2008 Natural and Cultural Values Evaluation Sheet, 3 Geoscience (22/02/2008), obtained from Forestry Tasmania by the Tasmanian Greens (released under the *Freedom of Information Act 1991*).

WATSON, J., HAMILTON-SMITH, E., GILLIESON, D. & KIERNAN, K. (Eds) 1997 *Guidelines for cave and karst protection*. WCPA Working Group on Cave and Karst Protection, IUCN: Gland, Switzerland & Cambridge, UK, p. 33.