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INCEPTION AND SUBSEQUENT DEVELOPMENT OF CONDUITS IN THE CUILCAGH KARST, IRELAND



LESLIE BROWN

A thesis submitted to the University of Huddersfield in partial fulfilment of the requirements for the degree of Doctor of Philosophy

NOVEMBER 2005

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Figure 1. Sketch sections illustrating the origin and development of a large cavern by Gardiner (1935) (From Lowe, 2000).

salt water intrusion	dunes platfor-	T KARST ROC-		et deposit	et depositer KARST ROC- CUMULATING dunes platter banks lagoc
-------------------------	----------------	--------------	--	------------	--



Figure 2.



Figure 3. The 'four state model' (Ford, 1971).

4. Mar. 1

			TYI	PE OF RECHARGE		
		VIA KARST D	EPRESSIONS	DIFF	USE	HYPOGENIC
		SINKHOLES (LIMITED DISCHARGE FLUCTUATION)	GREAT DISCHARGE FLUCTUATION)	THROUGH SANDSTONE	INTO POROUS SOLUBLE ROCK	DISSOLUTION BY ACIDS OF
		BRANCHWORKS (USUALLY SEVERAL LEVELS) & SINGLE PASSAGES	SINGLE PASSAGES AND CRUDE BRANCHWORKS, USUALLY WITH THE FOLLOWING FEATURES SUPERIMPOSED:	MOST CAVES ENLARGED FURTHER BY RECHARGE FROM OTHER SOURCES	MOST CAVES FORMED BY MIXING AT DEPTH	DEEP-SEATED SOURCE OR BY COOLING OF THERMAL WATER
ITY	FRACTURES	S Stall		XXX	ISOLATED FISSURES	1 Alt
SOF		PASSAGES	FISSURES	FISSURES, NETWORKS	AND RUDIMENTARY NETWORKS	NETWORKS, SINGLE PASSAGES, FISSURE
104	VGS	. 1 8	in	PROFILE:		132



Figure 4. Cave patterns and their relationship to types of recharge (Palmer, 1991).

Simplified view of the life cycle of conduits/caves within a single "tier" of a typical carbonate succession, indicating:



U	Terminology	in common	and inf	formal use;	
---	-------------	-----------	---------	-------------	--

- 2 Part of the terminology developed by Worthington (1991);
- ③ Terminology used by Lowe (1992a).

Elapsed TIME, increasing from left to right, is not to scale

true po "cave" o	origin transition	nal change	Turbulent flow begins	Major growth phases	can be complex and multiphase	Host rock removed
3	INCEPTION	GESTATION		DEVELOPMENT	ABANDONMENT and DESTRUCTION	3
		1			1	
2	INITIATION PHASE	LAMINAR FLOW NOTHEPHREATIC PHASE		SYNGENETIC AND PARAGENETIC CONDUIT GROWTH PHASES	STAGNATION AND DESTRUCTION PHASES	2
		1				
1	INIT	ATION		various phases of DEVELOPMENT	abandonment and eventual removal	1
NO	-> CONDUIT GROWTH ->		TURBULENT	GROWTH	DECAY OF CAVES	NO CAVES

Tertiary igneous dyke

- owlan Shale Formation
- riscloonagh Sandstone Formation
- arraun Shale Formation
- lenade Sandstone Formation
- eenymore Formation
- artry Limestone Formation
- Member ŝ
- lencar Limestone Formation
- enbulben Shale Formation
- ullaghmore Sandstone Formation
- undoran Shale Formation
- allyshannon Limestone Formation
- sortian Limestone Nar
- rumgesh Shale Formation
- Moinian Supergroup

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and southwest Fermanagh of map





Symes and Wilkinson (1886) Wilkinson and Cruise (1886) Fermanagh	Oswald (1955) Sligo Syncline	Sheridan (1972) North-West Carboniferous Basin	Brunton and Mason (1979) Fermanagh	GSNI (1998)	STAGES
Upper Limestone	Dartry Limestone	Upper (Daruy) Limestone	Dartry Limestone	Dartry Limestonc Formation	Acres
	Glencar Limestone		Glencar Limestone	Glencar Limestone Formation	(part)
Middle or Calp Limestone	Benbulben Shalc	Upper Calp Shale	Benbulben Shale	Benbulben Shale Formation	HOLKERIAN
Middle or Calp Sandstone	Mullaghmore Sandstone	Upper Calp (Macnean) Sandstone	Mullaghmore Sandstone	Mullaghmore Sandstone Formation	ARUNDIAN



Figure 7. Nomenclature for the Dinantian sequence of the Northwest Basin of Ireland (GSNI, 1998). Crown copyright. Reproduced with permission.









Silesian rocks



Devonian rocks







7









Figure 10. Generalised geology of the Lough Allen Basin. (Kelly 1996).

ξ.



		王王		
			Gortalughany Member	
			Knockmore Member	
				Glencar Limestone Formation
F	lolkerian Arundian			Benbulben Shale Formation
Figure 11.		The sub 1996).	odivision of the L	Dartry Limestone Formation (After Kelly,



Co. Cavan

Figure 12.

Simplified contours showing the depth to the top of the Ballyshannon Limestone Formation. Depths are shown in metres above seismic datum of +50 m OD. BD = Big Dog Borehole, KC = Kilco Cross Borehole, McN = MacNean Borehole and S = Slisgarrow Borehole (GSNI, 1998). Crown copyright. Reproduced with permission.

Tertiary igneous dyke

Gowlan Shale Formation

Briscloonagh Sandstone Formation

Carraun Shale Formation

Glenade Sandstone Formation

Meenymore Formation

Dartry Limestone Formation

Knockmore Member

Glencar Limestone Formation

Benbulben Shale Formation

Mullaghmore Sandstone Formation

Bundoran Shale Formation

Ballyshannon Limestone Formation

Waulsortian Limestone

Drumgesh Shale Formation

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showing map of Cuilcagh Mountain ission. Geological

perm

3 Figure



Figure 14.

Part of the dyke swarm of southwest Fermanagh (Gibson & Lyle, 1993).



6	Lough	Kilometres		
	Proven underground connexion			
		0	1	
	Stream rising			
-	Stream sink			
	Keed		+	

Figure 15.

Summary of Gunn's water tracing experiments in the West Cuilcagh karst (Gunn, 1982).



Figure 16. Summary of Gunn's water tracing experiments in the North Cuilcagh karst (Gunn, 1982).









Tertiary igneous dyke







section A-A' (Figure 20) (After GSNI, 1997). Crown copyright. Reproduced with permission.

12



Figure 20.

Schematic reconstruction of facies distribution along cross-section A-A' (Figure 19) of the Dartry Limestone Formation within the Lough Allen Basin. (Modified after Kelly 1989).





Briscloonagh Sandstone Formation Carraun Shale Formation Glenade Sandstone Formation Meenymore Formation Dartry Limestone Formation **Glencar Limestone Formation Benbulben Shale Formation** Mullaghmore Sandstone Formation **Bundoran Shale Formation Ballyshannon Limestone Formation Drumgesh Shale Formation**





14



5



Figure 24.









40 \$ Positive anomaly of 200nT Negative anomaly of 700nT 35 35 30 30 Transect 1 Chart 2. Cuilcagh Dyke - Transect 2 25 25 . 20 metres 20 metres Chart 1. Cuilcagh Dyke 15 15

Geophysical sections traversing the Cuilcagh Dyke (Sections 1 to 4) (see Figure 24 for plotted

















Transect 7

Negative anomaly of 400nT

47000 -





























(Sections 13 to 15) (see Figure 24 for plotted trace and Table 7 for data).



Negative anomaly of 500nT Negative anomaly of 150nT Chart 13. Cuilcagh Dyke - Transect 13 Chart 14. Cuilcagh Dyke - Transect 14 metres metres

Geophysical sections traversing the Cuilcagh Dyke (





Figure 29.

The distribution of karst landforms and caves in the East Cuilcagh Karst.



Figure 30.

Geological map of the East Cuilcagh karst (After GSNI, 1997) (See Figure 31 for schematic cross-section). Crown copyright. Reproduced with permission.



21

0 1 2 3 4 5 6 7 8 Distance in kilometres

Schematic cross-section showing the fault block topography of the Figure 31. East Cuilcagh Escarpment (see Figure 30 for section plan).



Figure 32. Summary of catchments to risings in the East Cuilcagh Karst.










Southwest

Northeast





Figure 37. Rose diagram showing trends of fractures observed both underground in the caves in the area of Peter Bryant's Bullock Hole and over ground above the cave system (compiled using Stereonet).

25



3-Dimensional representation Compiled by Toporobot and Geo3D





Plan section and generated 3D image of Pigeon Pot II compiled by the Figure 38. author (See Figure 39 for section view, which includes high level passages discovered off Section 3).



Section of Pigeon Pot II with geology annotated from geological logs Figure 39. 1, 2 and 3 (Figures 40, 41 and 42).

Section: 1. Entrance Shaft, Pigeon Pot II, East Cuilcagh. Bench Mark (BM): Fixed anchor at pitch head



Logged by: Les Brown

Figure 40.

Geological log 1 of Pigeon Pot II entrance shaft (see Figures 38 and 39 for cave plan and section).

Section: 2. Entrance Rift to top of Lower Rift Chamber, Pigeon Pot II, East Cuilcagh. Bench Mark (BM): Fixed anchor at pitch head Logged by: Les Brown



Geological log 2 of Pigeon Pot II entrance shaft (see Figures 38 and Figure 41. 39 for cave plan and section).

1.0

28

Section: 3. Lower Rift Chamber, Pigeon Pot II, East Cuilcagh. Bench Mark (BM): Fixed anchor at pitch head

Logged by: Les Brown



Geological Description

UNIT 3

Carbonate mudstone (micrite) with chert. Micrite beds up to 0.9m thick. Cherts form beds up to 0.4m thick but are also abundant as irregular nodules within the micrite beds (PP3.1). Silicified coral and crinoid fragments are also abundant within the micrite.

UNIT 4

Packstone with interbedded shale and chert. Micrite beds up to 0.5m thick (PP3.2). Cherts form thin beds up to 0.2m thick but are also abundant as irregular nodules within the micrite beds. Upper contact between micrite is gradual. However, lower contact is sharp (PP3.3).

UNIT 5

Carbonate mudstone (micrite) with chert The micrite forms beds that are typically 0.3-0.5m thick. However, one bed at the top of this unit is up to 1.4m thick (PP3.3 & PP3.4). This thick micrite bed also has prominent solution runnels just below the contact (PP3.2). A thin shaley horizon overlies the micrite, which appears to be highly weathered forming as distinctive negative feature in the cave wall, which can be follwed laterally. A high level passage extends from this shaft both SW and NE along this horizon.

Although micrite dominates this sequence, the chert form up to 30%. Generally the chert form beds up to 0.3m thick. Some chert beds are tabular (PP3.5), whilst others are irregular and wavy. Silicified coral and crinoid fragments are common within the micrite beds.

Figure 42.

Geological log 3 of Pigeon Pot II entrance shaft (see Figures 38 and 39 for cave plan and section).

29



The location of Badger Cave and Badger Pot, with Poll-na-mona. Figure 44.





Linear gradients for sinks draining to Sumera Rising and Gortalughany Figure 45. Rising.

30



Figure 46. The distribution of karst landforms and caves in the Erne Karst, with subdivision into Eastern, Central and Western Marlbank.

W Palaeo-sea level Basin Ramp Shallow water Mud mounds (Knockmore Member)



Figure 47. The generalised structure of the sea floor of the Lough Allen Basin during Early-Asbian time (see Figure 1 for extent of Lough Allen Basin).

0	Sealevel		
200	Jea Level	Photic zone	
200	Storm base		
400		Mud mound	Basement

....

Figure 48. The depositional setting on the carbonate ramp (Bridges et al., 1995).

Shallow-water

carbonates



Figure 49. Horizontal growth of laterally extensive carbonate mud mounds (Lees, 1963).



Figure 50. Growth of 'vertical-type' carbonate mud mounds. (Lees, 1963).



Figure 51.

Schematic diagram showing the authors interpretation of the Knockmore Member mud mound complex. The interpretation is based upon observations in underground, in Skreen Hill I passage of Marble Arch Cave (see Figure 63 for cave survey), and over ground on Skreen Hill, which forms the topography above the cave system.



33







Figure 52.

TULLYHONA **RISING CAVE** Co. Fermanagh GR H 1533 3373

Surveyed to BCRA Grade 3 by The Reyfad Group G. L. Jones, H. Ball, M. Neill, D. Atkinson and G. Burns

Tullyhona 1 surveyed by P. & S. O'Reilly



Survey of Tullyhona Cave (Jones et al., 1997). Figure 53.





Figure 55. The caves and landforms of the Central Marlbank, of the Erne Karst.



Figure 56. Survey of Prod's Pot (Jones et al., 1997).

35



Survey of Cascades Rising Cave (Jones et al., 1997). Figure 57.



Rose diagram showing Figure 58. trends of fractures observed both underground in Prod's Pot and over ground above the cave system (compiled using Stereonet).

36



Figure 59. Rose diagram showing trends of fractures observed both underground in Cascades Resurgence Cave and over ground above the cave system (compiled using Stereonet).



Figure 60. The Owenbrean Upper and Lower Sinks.

37

Key

A=Surface flow upstream of Upper Sinks B=Conduit capacity of Upper Sinks C=Excess surface flow from Upper Sinks D=Conduit capacity to F1 E=Conduit capacity of rising F(1&2)=Conduit system draining to Formations Passage, Prod's Pot G=Surface flow immediately downstream of Upper Sinks H=Conduit capacity of Lower Sinks P=Surface flow to Pollasumera

Owenbrean Upper Sinks



Owenbrean Lower Sinks



Formation Passage

Owenbrean Upper Sinks 1. If A \leq B then C =0 2. If A>B then C =(A-B) 3. If B \leq D then E=0 4. If B>D the E=(B-F1) 5. G=C+E

Owenbrean Lower Sinks 1. If G≤H then P=0 2. If G>H then P=(G-H)

38

Figure 61. Schematic model for flows at the Owenbrean Upper and Lower Sinks.



(Grand effort	20 0 28 40 80 80 103	B) Upper Cradle
CA Annarcon in	E.A.Martel strue 1895	

Figure 62. Survey of the Marble Arch Cave by Martel (1895) and the modern survey of the same passages (Jones *et al.*, 1997).





Figure 64. Rose diagram showing trends of fractures observed both underground in Marble Arch Cave System and over ground above the cave system (compiled using

Stereonet).



	· · · · · · · · · · · · · · · · · · ·	

Figure 65. Survey of fracture patterns in Skreen Hill I of Marble Arch Cave.

40



Survey of Pollnagossan Cave (Jones et al., 1997). Figure 66.



0 1

Distance from rising (Kilometres)

Linear gradients from sinks to risings in the Erne karst. Figure 67.





Figure 68. Caves and landforms of the Shannon Karst.



Glenade Sandstone Formation
Meenymore Formation
Dartry Limestone Formation





Figure 69. The geology of the Shannon Karst (GSNI, 1997). Crown copyright. Reproduced with permission.

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	Pollnahune (S2a)		Magnetic
Shannon Pot	15	JCP Passage	North Grid



Figure 71. Survey of Shannon Cave, Polltullyard (Jones *et al.*, 1997) and Shannon Pot Rising (after Elliot and Solari, 1972).

43

Section: 1 of 1. Polltullyard Main Shaft. Bench Mark (BM): Fixed anchor at pitch head



Logged by: Les Brown

Geological Description

Carbonate mudstone (micrite) with cherts. Micrite beds up to 0.8m thick. Cherts form prominent beds, frequently wavy (PT1) are up to 0.4m thick but also occur as abundant irregular nodules within the micrite beds. Silicified coral and crinoid fragments are also abundant within the micrite. The basal contact is sharp but curvaceous (PT2). Strike/dip124/09 NE.

Carbonate mudstone (micrite) with spary calcite cavity infill (stromatactis) becoming more frequent lower within the unit. Silicified corals and crinoids are abundant in the top 10m of the unit (PT3 & PT4). The majority of fossil remains being broken and fragmented.

Calcite veining and fracturing are abundant in the shaft section (PT5). These tectonic features are typically orientated NW-SE and NE-SW, which corresponds to the orientation of cave passages. Veining is commonly en-echelon (PT5).

The micrite is massive, with infrequent bedding. A number of stylolites and thin pressure dissolution seams become more common lower in the unit (PT6 and PT7).

Figure 72.

Geological log of Polltullyard (see Figures 71 for cave plan and section).



 Legheelan Lower - Gowlan 1 Pollnaowen a - Pollboy - Garvagh 1 Pollahune — Tullynakeeragh Derrylahan 1 ---- Derrylahan 5 Polltullyard Killykeeghan 5 Killykeeghan 8 Pigeon Pot II Badger Pot

Linear gradients from sinks to risings in the Erne karst. Figure 73.



Figure 74. Summary of water tracing experiments on Cuilcagh Mountain.

45



Figure 75. Location map for plates of sites in Marble Ach Cave (see Figure 76 for

insert).



Figure 76. Location map for plates of sites in Skreen Hill I of Marble Ach Cave.





In the modern environment speleothem is being eroded rather than deposited



Spelethem deposited in more isolated reaches of the cave. MAC 1 &3 32-4.5ka



Rivers re-invade cave system. Erodsion of sediment fil and speleothml



Fluvio-glacial sediment deposited in cave. High energy environemnt which rodes speleothem.Partially filling the system with gravel and cobble fill.

Spelethem deposited over course sediment fill.



Spelethem deposited MAC4 & 6 (>350ka-200ka)

Figure 77. Summary of the sequence stratigraphy of cave sediments in Marble Arch Cave.

47





Ulster Basin Sedimentary Rocks



Lough Neagh Clays Oligocene

Chalk and Greensand (Cretaceous)

Shales, marls and sandstones (Triassic)



Figure 78. The Mesozoic and Cainozoic rocks sequence of Ireland (After GSNI, 1997). Crown copyright. Reproduced with permission.

North



Figure 79.

The distribution of the Palaeogene and Neogene palaeokarst sediments in Ireland (Modified after Naylor, 1992).





Figure 80. The distribution of glacial landforms within the Irish landscape (Warren, 1985) (see Figure 81 for details of insert).



Figure 81.

Distribution of glacial landforms in southwest Fermanagh (GSNI, 1998). Crown copyright. Reproduced with permission.





NW Europe stages	British stages	Irish stages	Events
Holocene	Flandrian	Littletonian	
			Nahanagan stadial
			Woodgrange Interstadial
			Drumlin phase Glenavy Stadial Main phase
Weichselian	Devensian	Midlandian	Derryvree Interstadial
			Hollymount Cold Phase
			Aghnadarragh Interstadial
			Fermanagh Stadial
Eemian	Ipswichian	Last Interglacial	?
Saalian	Wolstonian	Munsterian	Stadia with Scottish and Irish influence
Holsteinian	Hoxnian	Gortian	Benburb Interglacial
Elsterian	Anglian	Pre-Gortian	?

Figure 83.

Irish glacial stratigraphy (GSNI, 1998). Crown copyright. Reproduced with permission.



Plate 1.

Sandstone cliffs near Cuilcagh summit. (Les Brown).



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Plate 2. The mud mound topography of the Marlbank Escarpment. (Richard Watson).



Plate 3. A vertically extensive mud mound from the Knockmore Member of the Dartry Limestone Formation. Limekiln Hill, Marlbank. (Les Brown).



Plate 4. The well-bedded limestones with chert bands of the Gortalughany Member, Gortalughany Quarry, East Cuilcagh. (Les Brown).

52



Plate 5. Limestone pavement showing the dip slope located at the top of the Dartry Limestone Formation on the East Cuilcagh Escarpment. (Richard Watson).



Plate 6. Pollnadad Cave at the head of a dry valley, with annotated geology. (Les Brown).

53



Entrance shaft of Pigeon Pot II. (Garret Devitt). Plate 7.



of the Dartry Limestone Formation. (John Gunn).





Plate 10. Half tube in roof of Badger Cave. (John Gunn).



Plate 11. Sample of intramound horizon taken from Skreen Hill I of Marble Arch Cave, showing the relative abundance of shell fragments and ferric iron. (John Gunn).





Plate 12.

The stromatactis structure commonly found within the vertical-type mud mounds. Showing shelter cavities associated with bryozoa and final stage blocky calcite spar. (John Gunn).

56



Plate 13. Sample of an intramound horizon from Skreen Hill I of Marble Arch Cave, which shows the development of pressure dissolution within the unit. (John Gunn).



Plate 14. Dolomitisation of micrite where stromatactis cavities exist gives the rock a gnarly texture. (John Gunn).



Plate 15. Cascades Rising showing the thinly bedded nature of the Glencar Limestone Formation. (John Gunn).



Plate 16. Pollasumera stream sink during low flow. (Tim Fogg).



Plate 17. The author beneath the Marble Arch natural rock bridge in high flow conditions. (Laura Walsh).






Plate 19. Bifurcation of the Hune Stream. Left hand stream drains to Pollnahune and right hand stream to Tullynakeeragh Gravel Lake. (Les Brown).



Plate 20. Soft sediment slumping in the Knockmore intramound at Journey's End of Skreen Hill I, Marble Arch Cave (see Figure 75 for location). (Les Brown).



Plate 21. Speleothem deposition from seepage draining from the Knockmore intramound on the up dip side of Skreen Hill I, Moses Walk in Marble Arch Cave (see Figure 75 for location). (Les Brown).



Plate 22. Speleothem deposition from seepage draining from the Knockmore intramound on the up dip side of Skreen Hill I, Moses Walk in Marble Arch Cave (see Figure 75 for location). (Les Brown).



Plate 23.The Knockmore intramound on the down dip side of Skreen Hill I,
Moses Walk in Marble Arch Cave (see Figure 75 for location). (Les
Brown).



Plate 24. Speleothem forming a 'false floor' that indicates the level to which sediment had filled the passage, Legnabrocky Way, Marble Arch Cave (see Figure 76 for location). (Les Brown).



Plate 25. Rock step between the Sand's Chamber and Skreen Hill II records 0.75m of stream incision since Cascades and Marble Arch Cave became separated (see Figure 76 for location). (Les Brown).





Plate 27.

Location of sample MAC1, Skreen Hill II, Marble Arch Cave. Stalactite had been displaced and was lying on side covered in finegrained sediments (see Figure 76 for location). (Les Brown).



Plate 28.

Speleothem sample MAC3 (left) in Skreen Hill II, Marble Arch Cave. Fine sand covers the base of the stalagmite (see Figure 76 for location). (Les Brown).





Plate 29. Sample MAC4. Broken speleothem in partially consolidated fluvioglacial till, Legnabrocky Way, Marble Arch Cave (see Figure 76 for location). (Les Brown).



Plate 30. Speleothem sample MAC6 in Legnabrocky Way, Marble Arch Cave. Large slab of broken flowstone embedded in the stream floor. Sample is partially covered by well-rounded sandstone boulders (see Figure 76 for location). (Les Brown).

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Plate 31. 'Mud towers' formed in very fine grained sediments, Legnabrocky Way, Marble Arch Cave (field of view = 0.6m). (See Figure 76 for location). (Les Brown).





Plate 32. Fine grained sediments, Legnabrocky Way, Marble Arch Cave (see Figure 76 for location). (Les Brown).



'The Castle' a relict rim stone pool speleothem in Marble Arch Cave Plate 33. (see Figure 75 for location). (Les Brown).



Flowstone speleothem in Skreen Hill II of Marble Arch Cave (see Plate 34. Figure 75 for location). (Les Brown).

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Plate 35. Remnant of partially consolidated gravel fill beneath flowstone (Plate 34). (Les Brown).





Plate 36. 'The Paddy Fields' a rim stone pool speleothem with embedded sandstone boulders, Skreen Hill I of Marble Arch Cave (see Figure 75 for location). (Les Brown).

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svstem	Grid reference	Altitude	Depth of	Average linear	Linear sink-rising
d to rising	(Irish Grid, 1964)	(m AOD)	cave (m)	velocity (m/h)	gradient (m/km)
o (GR:217842-328253, Alt 139m)					
icka 8	216460-328969	298	70		102
Pot 8	216540-329467	302	60	30	86
Pot 8	216384-330027	305	9		72
anaclanawly ⁸	216448-329539	301	63	30	85
n Pot II ⁸	215712-330526	298	52	45	51
r Pot ⁸	215543-330670	301	5	50	60
7 Rising (GR: 217126-330024, Alt: 239m)					
n Pot II ⁸	215712-330526	298	52	20	41
r Pot ⁸	215543-330670	301	5	25	33
/ Intake Rising (GR: 216437-330438, Alt 239m)					
n Pot II ⁸	215712-330526	298	52	<20	46
r Pot ⁸	215543-330670	301	5	<20	39
⁷ Farmvard Rising (GR: 216837-330637. Alt 243m					
n Pot II ⁸	215712-330526	298	52	<20	52
r Pot ⁸	215543-330670	301	5	<20	40
Brodrick (1908); ² Wynn (1956); ³ Holgate (1954); ⁴ Devoy	y and Orr (1970); ⁵ Jone	s (1974), p.92;	⁶ Gunn (1982);	⁷ Gunn (1996); ⁸ Gunn	n <i>pers. comm.</i> , (1998).

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4

SIC East Cuilcagh Escarpment by previous autho



Cun (1982); Gunn and Orr (1970); ² Jones (1974), p.92;

Summary of all water tracing experiments on the

R05 Gortalughany B18 Pigeon B22 Badger 7 Gortalughany G08 Pollini G13 Black | B03 B.M.C B16 Polltha B18 Pigeon B22 Badger to drainage s Sinks traced B18 Pigeon B18 Pigeon **R03 Sumera Risin B22** Badge Gortalughany Rising R06 R07 Notes

-----Table

Linear sink-rising	grauterin (IIIV MIII)	120	83		59		49	50	51	33	42	32	44	54	53	55	49	57	60	58	58	49	pers. comm., (1998).
Average linear		77	50		<30	260	120	260	300	>80		78	75		>34	320*	32	150			50		⁷ Gunn (1996); ⁸ Gunn
Depth of	cave (IIII) 1	12			15		7				•	52	5	15	17	t		•	•		15		⁶ Gunn (1982);
Altitude		238	220	236	328		231	220	218	243	214	298	301	328	169	197	159	166	218	209	208	171	:(1974), p.92;
Grid reference	(HOAT '170H)	21503-33335	21457-33338	21545-33332	215717-331390		21396-33372	21453-33339	21421-33339	212782-331986	213298-327740	215712-330526	215543-330670	215717-331390	21166-33374	21302-33319	21195-33350	20965-33496	20767-33553	20730-33735	20625-33528	20544-33527	and Orr (1970); ⁵ Jones

risings on the northern part of the Marlbank Escarpment by previous authors.

	ŀ
system	
passage traced to rising	_
ng (GR:21533-33373, Alt 193m)	
loles ⁵ (Via oxbow Inlet)	
1°(Via oxbow Inlet)	
8 S	
ot ⁸	
g (GR: 21228-33498, Alt 119m)	
m Sump 1 in Prods Cave ⁴	
ountain ⁶	<u> </u>
36	
86	<u> </u>
u Upper Sinks ⁸	
Lower Sinks ⁸	
n Pot II 7 and 8	<u> </u>
r Pot ^{7 and 8}	· ·
ot 7 and 8	÷
Rising (GR: 2121-3344, Alt: 128m)	
a (Cats' Hole) ⁴	
a 5	
Rising (GR: 21045-33663, Alt 83m)	i L
9	
(GR: 20783-33735, Alt: 83m)	L
ı Sink ⁸	
Pot ⁸	
:R: 20418-33596, Alt: 77m)	
n 6	
ge 6	1 1
3rodrick (1908) ² Wynn (1956); ³ Holgate (1954); ⁴ Devoy	-
mary of all water tracing experiments to risi	

t

ising to drainage	Sinks/cave	1 Tullyhona Ris	Whiskey I	Brookfield	Dicks Sink	F03 Goat]	1 Cascades Risin	Downstrea	Smokey N	Brookfield	Brookfield	Owenbrea	Owenbrea	B18 Pigeo	B22 Badge	F03 Goat I	[33 Marble Arch	Sruh Crop	Pollasumer	Monastir ¹	1 Hanging Rock	Legacapple	ure Main Rising	Legnaveag	Super Star	arran Rising 1 ((Pollnagoss	Pollnaskeo		e 2. Sum
Ri		T1					IJ										M3				HI		Tul			Bar			Notes	Table

Rising	g to drainage system	Grid reference	Altitude	Depth of cave	Average linear	Linear sink-rising
	Sinks traced to rising	(Irish Grid, 1964)	(m AOD)	(m)	velocity (m/h)	gradient (m/km)
Shanı	non Pot Rising (GR:205406 331814, Alt 106 m)					
	Legeelan Lower ⁶	206788-333698	164	2	120	24
	Gowlan 1 ⁶	206767-333556	157	2	130	25
	Pollnaowen ⁶	206890-333224	154	4	240	22
	Pollboy	206979-332827	149	8	(80-250)	23
	Garvagh 1 6	207776-332879	167	1	60	29
	Pollnahune stream sink ⁶	209447-332410	252	3	<90	36
	Tullynakeeragh 6	209767-331887	276	6	105	40
	Derrylahan 1 ⁶	205979-332012	128	2	50	60
	Derrylahan 5 ⁶	205521-331809	138	1	140	70
	Polltullyard ⁸	209441-332418	261	48	•	39
	Killykeegan 5 ⁸	209415-332810	189	1		33
	Killykeegan 8 ⁸	210231-332185	236	9		32
	B18 Pigeon Pot II 7 and 8	215712-330526	298	48	100	20
	B22 Badger Pot ^{7 ad 8}	215543-330670	301	5	85	22
Notes	¹ Brodrick (1908) ² Wynn (1956); ³ Holgate (195 Note that multiple traces have been u); ⁴ Devoy and Orr (1970) idertaken from som	; ³ Jones (1974) e sinks.	, p.92; ⁶ Gunn (1982);	⁷ Gunn (1996); ⁸ Gunn	<i>pers. comm.</i> , (1998).

2

Summary of all water tracing experiments to risings on the southern part of the Marlbank Escarpment by previous authors.

Table 3.

					Sam	pling du	Iring low	r flow (2	2 nd -24 th	lanuary	1997)				
	Temp	Hd	Cond.	HCO3	ວ	ŝ	so.	Ca	ßW	Na	¥	Fe	S	∂ ¹³ CPDB	θ ³⁴ Scdt
	ပ္စ		µS/cm	mg/l	ng/	ng/	ng/	ng/	l/ĝm	ng/	l/gm	ng/	ng/		
st	((0				(,		۲ ۲		0 1 R		0 0
		0.73	222	<u>6</u> 2	0 0		1 0 1 t	 	, a				00 0		1. 2/2
(2)	7.10	11.7	101	20	7.7	7.L		0.22	0 V	0.0	N .2		0.00	0	
e (R06)	8.30	7.64	352	165	6 .0	0.0	5.6	55.1	4.3	6.5	0.3	0.1	0.15	-12.7	9.2
							·								
	7.10	8.31	245	105	9.1	0.8	4.5	34.4	2.2	7.3	1.0	0.3	0.29	-18.7	6.6
	8.20	8.07	257	127	8.6	0.0	4.8	36.5	5.1	5.4	0.9	0.1	0.27	n/s	n/s
	5.00	7.87	108	5	7.3	0.4	6.2	12.7	1.9	6.6	0.5	0.3	0.15	n/s	n/s
Walk	8.50	7.87	467	239	8.3	3.0	3.9	77.7	5.4	6.7	0.5	0.1	0.15	-14.5	14.5
	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
	8.50	8.33	426	207	13.8	6.6	7.2	68.5	15.5	7.7	1.0	0.1	0.15	n/s	n/s
	9.10	7.91	400	196	12.1	4.5	5.1	65.6	11.1	6.4	0.5	0.1	0.14	n/s	n/s
ו Rising	8.60	7.39	416	196	11.7	5.2	5.2	70.9	2.6	8.2	2.9	0.1	0.18	-16.5	10.0
	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
	9.00	7.07	607	249	19.2	8.8	8.8	77.9	3.4	10.9	0.9	0.1	0.28	-15.0	4.4
	8.30	7.82	549	271	11.7	17.1	4.4	113.2	1.6	6.2	1.1	0.1	0.18	n/s	n/s
	9.30	7.27	535	322	13.2	8.5	5.7	94.7	5.3	7.5	0.9	0.1	0.44	-15.7	7.6
	6.40	8.20	566	328	14.7	10.5	10.3	86.6	4.0	9.5	0.8	0.1	0.38	s/u	n/s
	7.70	7.42	254	95	15.9	1.0	5.4	35.6	6.1	8.3	0.7	0.2	0.11	-23.3	9.2
	7.40	6.73	427	206	13.9	1.3	6.4	71.4	2.4	8.9	1.7	0.4	0.17	s/u	n/s
	6.00	7.04	710	322	19.0	0.0	5.2	88.2	3.0	22.9	3.4	0.1	3.30	-16.0	38.3
		•													
~	6.80	7.38	209	62	10.7	1.6	5.8	23.7	2.2	7.3	1.0	0.3	0.29	-18.7	6.6
mical analy ablished wo	ses of ei rk by N	mergen eil Web	t waters ber, Lii	from k meston	arstic r e Resea	isings i rch Gro	n the C oup, Un	uilcagh iiversit	upland y of Hu	ls durin ddersfie	g low f eld).	low coi	ndition	s (Based	uo

East Cuilcagh Kar	Aghaboy Springs (F	Sumera Rising (R0:	Gortalughany Intake	Erne Karst	Tullyhona Rising	Cascades Rising	Marble Arch Rising	Inlet into Moses	Cladagh West	Cladagh West 1	Cladagh West 2	Hanging Rock Main	Ture Main Rising	Ture East	Ture West	Marlbank West	Marlbank East	Barran Rising 1	Barran Rising 2	Barran Rising 3	Shannon Karst	Shannon Pot Rising	e 4. Cher	ndum
																<u> </u>							Lable	

					Sa	mpling c	Juring h	igh flow	(24 th -26 ^t	^h May 19	96)				
	Temp	Ηd	Cond.	HCO3	ច	NO3	SO4	Ca	ßW	Na	¥	Fe	Sr	а ^{тз} Сров	3³⁴Scdt
	ပ္		pS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	ng/l		
jh Karst										1					
ings (R03)	6.6	7.74	275	148	α.α 8.3	2.1	3.5	22.0	Z.U	4./	4.0	0.2	0.14	-12.3	12.4
1g (R04)	7.80	6.92	126	51	6.0	0.9	5.2	19.0	2.4	4.2	0.6	0.3	0.23	n/s	n/s
/ Intake (R06)	8.20	7.60	313	172	10.5	0.6	5.4	60.0	4.2	5.0	0.4	0.1	0.26	-12.5	11.2
							<u>-</u> .								
sing	8.20	7.80	265	107	7.3	1.0	4.0	34.0	3.9	4.6	0.5	0.3	0.11	n/s	n/s
sing	9.20	7.99	182	25	6.9	1.3	3.5	27.0	3.6	4.2	0.5	0.3	0.36	n/s	n/s
Rísing .	8.90	7.21	68	36	5.2	0.4	3.2	10.0	1.2	3.6	0.5	0.7	0.02	n/s	4.0
es Walk	8.20	7.16	317	161	7.7	7.0	4.0	59.0	3.8	5.0	0.6	0.3	0.19	-15.6	8.8
÷	9.10	7.91	442	261	13.5	7.8	13.8	78.0	6.2	7.6	1.0	0.1	0.45	-13.1	-2.5
ř 1	11.90	8.26	343	176	14.8	6.6	8.4	62.0	4.9	6.9	0.9	0.1	0.26	n/s	n/s
ť 2	10.00	8.20	358	207	12.7	5.3	4.4	66.0	4.5	5.9	0.6	0.2	0.23	n/s	n/s
k East Rising	8.70	7.38	401	227	10.9	5.0	5.6	82.0	3.9	6.4	0.9	0.3	0.36	-15.3	6.7
sing	8.50	7.42	310	167	13.0	4.1	6.9	58.0	3.1	6.5	0.7	0.2	0.23	n/s	n/s
	9.50	7.04	529	287	17.0	10.8	9.1	104.0	4.9	8.4	0.8	0.2	0.46	-15.4	2.3
	9.30	7.30	488	276	13.5	18.1	4.6	0 .06	3.1	6.0	1.0	0.3	0.29	n/s	n/s
st	9.30	6.94	409	232	12.7	11.0	5.0	73.0	3.5	5.8	1.3	0.2	0.30	-16.1	7.9
ب ند	8.50	7.83	370	203	15.5	6.8	6.6	78.0	4.2	6.6	0.5	0.2	0.24	n/s	n/s
~	8.30	7.03	260	143	12.7	1.5	6.6	48.0	3.4	7.2	2.1	0.6	0.17	-14.2	10.7
N	7.90	7.55	254	124	14.2	1.2	5.9	51.0	3.0	6.7	0.8	0.3	0.15	n/s	n/s
ŝ	9.40	7.35	619	326	19.3	0.0	6.4	54.0	6.8	13.5	1.6	0.3	2.34	-13.7	30.6
Ş	<u> </u>									<u> </u>			<u> </u>		
Rising	8.20	7.37	187	98	9.4	1.4	5.8	29.0	3.1	5.6	0.8	0.5	1.19	-14.7	17.9
Chemical analys unpublished wor	es of en k by Ne	nergent il Web	waters ber, Lin	from kane	arstic ri Resea	sings ir rch Gro	n the Cu up, Un	uilcagh iversity	upland of Huc	s during ldersfie	g high f ld).	low coi	ndition	s (Based	Б

East Cuilcagh Kar Aghaboy Springs (F Sumera Rising (R04 Marble Arch Rising Inlet into Moses Wa Che Hanging Rock Eas Gortalughany Intal Shannon Pot Risin **Cascades Rising Ture Main Rising Tullyhona Rising** Cladagh West 2 Shannon Karst Cladagh West 1 Barran Rising 2 Barran Rising 3 Barran Rising 1 Marlbank West Marlbank East **Cladagh West Erne Karst Ture West Ture East**

Table 5.

Field mea	surements (January 19	97)
Site	Temperature ¹	Conductivity ²
	°C	μS/cm
Aghaboy Rising	7.5	56
Pollnagollum Aghaboy	7.6	47
Gortalughany Rising	7.7	150
Gortalughany Intake	8.2	370
Cascades Rising	8.2	257
Formations Passage	10.6	297
Cascade Inlet	7.6	114
Papist passage	9.5	207
Prods Downstream Sump	8.3	174

- 1 Measurements taken using a mercury thermometer
- 2 Measurements taken using a Jenway conductivity meter

Table 6.Additional field measurements taken during low flow (January 1997)to complement Table 4 and 5.

Location	Grid Ref	erence	Magnetic	Anomaly
Reference	Northing	easting	tN	nT
1	206249	335838	48867	-193
2	206391	335778	49182	122
Transect 1	206546	335753	49223	163
3	206694	335646	48338	-722
<u>A</u>	206865	335605	48081	-979
Transect 2	207068	335515	48368	-692
5	207290	335424	48095	-965
6	207521	335348	49882	822
Transect 3	207734	335250	49764	704
7	207966	335146	49121	61
8	208204	335043	49112	52
9	208441	334927	49177	117
Transect 4	208654	334870	48729	-331
10	209131	334377	49119	59
11	209432	334243	49127	67
Transect 5	209669	334118	49211	151
12	209924	334033	49179	119
13	210136	333967	48833	-227
Transect 6	210412	333799	48549	-511
14	210603	333757	48871	-189
15	210965	333608	48890	-170
Transect 7	211219	333417	49146	86
16	211411	333332	48842	-218
17	211538	333268	48876	-184
Transect 8	211750	333226	48697	-363
18	211942	333098	48860	-200
19	212153	333036	48645	-415
Transect 9	212362	332963	48987	-73
20	212569	332831	48698	-362
21	212754	332742	49199	139
Transect 10	212951	332682	49213	153
22	213201	332574	49258	198
23	213238	332526	49231	171
Transect 11	213328	332430	49095	35
Transect 12	213387	332367	49058	-2
Transect 13	213470	332307	48987	-73
24	213848	332121	48728	-332
25	214331	331935	48699	-361
Transect 14	214984	331638	48796	-264
26	215493	331354	48903	-157
27	215839	331186	48748	-312
Transect 15	216238	330995	48837	-223
28	216742	330773	48945	-115
29	217342	330507	48729	-331

Table 7.Magnetic data from measurement of the Cuilcagh Dyke from BurrenForest to East Cuilcagh using a proton magnetometer.

	Easting (m) (Irish Grid, 1965)	Northing (m) (Irish Grid, 1965)	Elevation (m) Above OD (Irish Datum, 1965)
Lower and Middle Escarpment			
Risings			
R01 Aghaboy Rising	217156	326425	167
R02 Aghaboy Springs	217496	328460	147
Landforms 'A' series			
A01 Pollnagollum Aghaboy	217000	326445	223
Upper Escarpment Greenan Fault Block			
Risings			
R03 Sumera Rising	217842	328253	139
R04a rising (27)	217232	328806	254
R04b rising (28)	217251	328942	255
R04c rising (29)	217232	329013	259
Landforms 'G' series			
G05 Quarry Crowbar caves	217700	327970	178
G06 Pollnadad	216569	328622	293
G07 Pollprughlisk	216485	328871	297
G08 Polliniska	216460	328969	298
G09 Pollnatagha	216473	328988	298
G10 Peter Bryant's Bullock Hole	216362	329194	302
G11 Long Pot	216440	329275	300
G12 Tea Pot	216330	329400	301
G13 Black Pot	216540	329467	302
G14 Dig Swallet	216488	329467	301
G15 Small Pot	216454	329537	300
G16 Pollthanaclanawley	216448	329539	301
G17	216596	329715	311
G18 Peter Bryant's Hole	216531	329636	309
G19	216597	329689	310

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Beihy Fault Block

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Risings			
R05 Gortalughany Rising	217126	330024	239
R06 Gortalughany Intake Rising	217437	330438	239
R07 Gortalughany Farmyard	216837	330637	243
Rising			
Landforms 'B' series			
B01	216382	329994	307
B02	216383	330004	303
B03 BMC Pot	216384	330027	305
B04 Coral Pot	216303	330075	305
B05	216303	330092	307
B06	216289	330125	308
B07	216224	330158	311
B08	216224	330189	311
B09	216230	330210	311
B10 Syringopora Pot	216392	330210	317
BII	216149	330240	311

B12	216102	330278	304
B13	216044	330315	304
B14	215955	330377	306
B15	215958	330414	305

Table 8(1). Grid References and elevations for karst landforms on the East Cuilcagh Escarpment.

	Easting (m)	Northing (m)	Elevation (m)
	(Irish Grid, 1965)	(Irish Grid, 1965)	Above OD (Irish Datum, 1965)
B16	215902	330485	305
B17	215744	330530	303
B18 Pigeon Pot II	215712	330526	298
B19 Pigeon Pot III	215750	330584	297
B20 Pigeon Pot I	215779	330634	298
B21	215561	306657	300
B22 Badger Pot	215543	330670	301
B23 Badger Cave	215538	330705	300
B24	215846	330762	294
B25	215855	330765	295
B26	215603	330771	295
B27	215698	330799	290
B28	215748	330811	2 96
B29	215908	330824	299
B30	215627	330833	300
B31	215732	330838	300
B32	215752	330888	301
B33a	215687	330908	287
B33b	215704	330907	290
B34	215724	330917	294
B35 Aghatirourke Pot	215628	330928	294
B36a	215772	330948	293
B36b	215786	330941	293
B36c	215809	330945	295
B36d	215822	330942	297
B37	215793	331001	289
B38 Sheep Pot	215571	331047	292
B39	215745	331085	289
B40	215724	331100	292
B41	215734	331117	301

Florence Court Fault Block

Risings

A1 / 2A

22140

R08 Florence Court Risings	21650	33140	230	
Landforms 'F' series				
F01	215915	331237	316	
F02	215717	331353	318	
F03 Goat Pot	215717	331390	328	
F04	215785	331405	321	
F05	215799	331425	319	
F06	215922	331362	315	
F07	215874	331446	320	
F08	215852	331547	325	
F09	215844	331585	327	
F10	215853	331611	330	
F11	215851	331671	329	
F12 Pollmyalla I	215844	331710	327	
F13 Pollmyalla II	215859	331747	326	
F14 Pollmyalla III	215926	331789	329	

Grid References and elevations for karst landforms on the East Cuilcagh Table 8 (2). Escarpment.

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eam sink where dye was injected

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- = No dye recovery, indicating isolation from the stream sink ł . . out during this research project. Showing str + <u> ----</u> + ____

	9	~	•	6	10
966	06/09/1996	27/07/1997	27/07/1997	24/01/1998	24/01/1998
alla	Peter	Aghatirour	Pollmyalla	Pigeon Pot	Badger
	Hole	Pot		=	
	•				•
	•	•	•	•	•
	•	+	•	+	+
	•	•		+	•
	•				•
	•	•	•	•	•
	•		•	•	•
	•	+	•	+	+
	•	+	•	+	+
	•	•		+	+
			•	•	
	•	•	•	•	
	•	•	•	•	•
	•	+	•	+	+
	•	•			•
	•		1	•	ł
		•		+	+
	vdraulic connecti	ion with the stree	am sink	- = No dye rec	overy, indicating
ed	out durin	e this res	earch nr	oiect. Sho	wing str
	-loon				
210	4NUII.				

Trace Ref:	+	~	2	•	•
Date:	26/03/1996	26/03/1996	10/07/1996	10/07/1996	06/09/199
Injection Point:	Black Pot	Polithana-	Goat Pot	Peter Bryant	Polimyalla 1
		clanawiey		Bulf Hole	
East Cuilcagh Karst					
Aghaboy Rising	•	•	•	•	4
Aghaboy Springs	•	•	•		•
Sumera Rising (Upper)	+	+	•	+	•
Sumera Rising (Lower)	+	+	•	+	•
Gortalughany Spring A	•	•	•	•	3
Gortalughany Spring B	•	•	•	•	•
Gortalughany Spring C	•	•	•	•	•
Gortalughany Rising (Upper)	•	•	•	•	•
Gortalughany Rising (Lower)	•		•	•	ŧ
Gortalughany Intake Rising	•	•	•	•	•
Gortalughany Farmyard Rising	-	•		•	•
Florencecourt Springs	-	•	•	•	+
Erne Karst					
Tullyhona Rising	•	ł	+	•	+
Cascades Rising	•	•	+	•	+
Marble Arch Rising	*			•	•
Cladagh West 1					
Cladagh West 2					
Springwell Rusing					
Hanging Rock Rising	•	•	•	•	•
Martbank Rusing (East)					
Martbank Rusing (West)					
Ture					
Comagee Lower					
Comagee					
Barran Rising 1					
Barran Rising 2					
Barran Rising 3					
Shannon Karst					
Shannon Pot Rising	•	•	3	•	•
Risings with + and - denote those mor	nitored during ead	ch trace	+ = Posi	tive dye recove	sry, indicating
Table 9. Sum	mary of v	water tra	cing exp	eriments	carried
			 -	•	
anu	Inose risi	ngs whe	re monuc	DTING Wa	s under

Grid reference	Altitude	Depth of	Average linear	Linear sink-rising
(Irish Grid, 1964)	(m AOD)	cave (m)	velocity (m/h)	gradient (m/km)
216460-328969	298	20		102
216362-329194	302	48		94
216540-329467	302	60	30	86
216531-329689	310	21	•	92
216384-330027	305	9	•	72
216448-329539	301	63	30	85
215712-330526	298	52	45	51
215543-330670	301	5	50	60
215628-330928	294	28	B	44
215571-331047	292	29	4	44
216224-330189	311	2		72
215712-330526	298	52	20	41
215543-330670	301	5	25	33
215628-330928	294	28		28
215571-331047	292	29		44
216224-330189	311	2		104
215712-330526	298	52	<20	46
215543-330670	301	5	<20	39
215628-330928	294	28		27
215571-331047	292	29		44
215712-330526	298	52	<20	52
215543-330670	301	5	<20	40
215844-331747	327	14	<10	<10
d Orr (1970); ⁵ Jones	s (1974), p.92;	⁶ Gunn (1982);	⁷ Gunn (1996); ⁸ Gunn	pers. comm., (1998).
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East Cuilcagh	Karst.			

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stem	
to rising	
(GR:217842-328253, Alt 139m)	
ka ⁸	
ryants' Bullock Hole Author	
ot 8 and Author	
ryant's Hole	
Pot ⁸	
aclanawly ^{8 and Author}	
Pot ^{8 and Author}	
ourke Pot Author	
ot Author	
Rising (GR: 217126-330024, Alt: 239m)]
Pot ^{8 and Author}	
ourke Pot Author	
ot Author	
ntake Rising (GR: 216437-330438, Alt 239m)	
Pot II ^{8 and Author}	
Pot ^{8 and Author}	
ourke Pot Author	
ot Author	
⁷ armyard Rising (GR: 216837-330637, Alt 243m	
KISINGS (GK: 21650-33140, AII: 230m)	
alla I	
odrick (1908); ⁴ Wynn (1956); ³ Holgate (1954); ⁴ Devoy	an

Summary of all water tracing experiments in the

KISING	to drainage s
	Sinks traced
R03 S	umera Rising
	G08 Pollini
	G10 Peter B
	G13 Black I
	G18 Peter B
	B03 B.M.C.
	B16 Polltha
	B18 Pigeon
	B22 Badger
	B35 Aghatir
	B38 Sheep I
	B08
R05 G	ortalughany
	B18 Pigeon
	B22 Badger
	B35 Aghatir
	B38 Sheep F
	B08
R06 G	ortalughany
	B18 Pigeon
	B22 Badger
	B35 Aghatir
	B38 Sheep F
R07 Go	ortalughany]
	B18 Pigeon
	B22 Badger
R08 Fl	orence Court
	E248 Pollmy
tes	I B

• Table 10

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Linear sink-rising	gradient (m/km)	120	83		50		67	•	49	50	51	33	42	33	44	54	53	55	49	57	65	59	60	58	58	49	1000 (1008)
Average linear	velocity (m/h)	77	50		30	<u>~</u> 0	<20	260	120	260	300	>80		78	75		>34	320*	32	150	80	50			50		Cunn (100K). 8 Cunn -
Depth of	cave (m)	12	•		15	9	7	•	7	ł	•			52	5	15	17		1		22	3	1	•	15		Gunn (1027). 7
Altitude	(m AOD)	238	220	236	328	327	326	•	231	220	218	243	214	298	301	328	169	197	159	166	174	174	218	209	208	171	(1074) ~ 07. 6
Grid reference	(Irish Grid, 1964)	21503-33335	21457-33338	21545-33332	215717-331710	215844-331747	215859-331747	J	21396-33372	21453-33339	21421-33339	212782-331986	213298-327740	215712-330526	215543-330670	215717-331390	21166-33374	21302-33319	21195-33350	20965-33496	21015-33477	20971-33459	20767-33553	20730-33735	20625-33528	20544-33527	A Ore (1070). 5 Innes

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experiments

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Table 11

vstem	⊢
passage traced to rising	
g (GR:21533-33373, Alt 193m)	4
oles ² (Via oxbow Inlet)	<u> </u>
• (Via oxbow Inlet)	
t 8 and Author	
Ila I Author	!
Ila II Author	
(GR: 21228-33498, Alt 119m)	
Sump 1 in Prods Cave ⁴	
untain 6	
0	
0	
Jpper Sinks ⁸	
Jower Sinks ⁸	
Pot II 7, 8 and Author	
Pot 7, 8 and Author	
t, 7, 8 and Author	
ising (GR: 2121-3344, Alt: 128m)	L
(Cats' Hole) ⁴	_1
ising (GR: 21045-33663, Alt 83m)	
Author	
thor	
3R: 20783-33735, Alt: 83m)	
Sink ⁵	
1	
6 20416-33290, AIII / /III/	
0	
odrick (1908) ² Wynn (1956); ³ Holgate (1954); ⁴ Devoy	a

Owenbrean I B18 Pigeon P B22 Badger F F03 Goat Pot Marble Arch R Tullyhona Risin Whiskey Ho Brookfield 1 Dicks Sinks F12 Pollmya F13 Pollmya Sruh Croppa Pollasumera Monastir Hammer Pot Cow Skull ^{Aut} Rising 1 (GR Pollnagossan Pollnaskeoge Smokey Mou Brookfield 3 Dwenbrean L Legnaveagh Super Star Po Rising to drainage s **Cascades Rising** Downstream anging Rock R Main Rising ((Legacapple Barran Ture **M33** L CI IHI Notes

_	1	`	Τ	1	T	<u> </u>	_	T	T	T		<u> </u>	T			
Linear sink-rising	gradient (m/km)		24	25	22	23	29	36	40	60	70	39	33	32	20	22
Average linear	velocity (m/h)		120	130	240	(80-250)	60	06≻	105	50	140				100	85
Depth of cave	(m)		2	2	4	8	1	3	6	2	1	48	1	9	48	5
Altitude	(m AOD)		164	157	154	149	167	252	276	128	138	261	189	236	298	301
reference	Grid, 1964)		88-333698	67-333556	90-333224	79-332827	76-332879	47-332410	67-331887	79-332012	21-331809	41-332418	15-332810	31-332185	12-330526	43-330670

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carst. \mathbf{N}

vstem	Gri
d to rising	(Irish
g (GR:205406 331814, Alt 106 m)	
ower ⁶	2067
	2067
9	2068
	2069
	2077
tream sink ⁶	2094
ragh ⁶	2097
16	2059
56	2055
20	2094
158	2094
188	2102
Pot II 7,8 and Author	2157
r Pot 7, 8 and Author	2155
3rodrick (1908) ² Wynn (1956); ³ Holgate (1954);	⁴ Devoy

water tracing in the Shannon] Summary of all

to drainage a	Sinks trace	on Pot Risin	Legeelan I	Gowlan 1 ⁶	Pollnaowei	Pollboy 6	Garvagh 1	Pollahune	Tullynakee	Derrylahan	Derrylahan	Polltullyare	Killykeega	Killykeega	B18 Pigeon	B22 Badge	
Rising		Shann															otes

Table 12.

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Deorintian C	5		23411,2381	S ²³⁴ U/ ²³⁶ U	230-1- ,234.	S ²³⁰ Th/ ²³⁴ U	23076,23276	Age			Corrected		
rescription	(mqq)	(I) ns	5	(Ŧ)		(Ŧ)		(ka)	s Age	-s Age	age (ka)	s Age	-s Age
MA 1/1, base	0.145	0.004	1.359	0.047	0.492	0.03	2.38	70.95	6.02	5.73	32.56	9.04	8.86
MA 1/9, top	0.073	0.003	1.448	0.074	0.255	0.035	10000	31.42	5.06	4.86			
MAC 3 base	0.068	0.003	1.382	0.063	0.121	0.015	12.1	13.9	1.88	1.85	12.29	2.09	2.06
MAC 3 top	0.073	0.003	1.407	0.085	0.106	0.019	2.36	12.03	2.34	2.3	4.56	3.77	3.75
MAC 4A base	0.056	0.002	1.369	0.071	0.96	0.053	31.4	244.81	53.21	37.16	240.79	53.68	37.58
MAC 4B top	0.042	0.001	1.3857	0.04081	0.9846	0.03061	10.0196	264.15	33.05	26.14	251.02	34.05	27.05
MAC 6A	0.032	0.002	1.4521	0.11174	0.9282	0.06437	25.5263	214.99	48.58	34.96	210.16	49.21	35.54
MAC 6B	0.024	0.001	1.2774	0.07477	1.0789	0.072	21.2222	>350					
MAC 6C	0.03	0.002	1.3866	0.11523	1.0966	0.06982	3.1127	>350					

(see Plates 27-30, and Figure 75)

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Results from uranium series dating of speleothem samples collected from Marble Arch Cave

Table 13.