



Tunnel Projects	Period	Tunnelling Technology	System	Geology	Prediction Targets
<u>METRO ATHENS Line 3 Extension</u> Greece	2016-2017	EPB TBM, Ø 9.5m, LOVAT	INTEGRAL	siltstones, serpentinites, limestones	Karst zones including large cavities
<u>Uma Ova Multipurpose</u> <u>Development Project, Sri Lanka</u>	2016-2017	2 Double Shield TBM, Ø 4.3m, HERRENKNECHT	INTEGRAL	gneisses	Fault zones, potential water-inflow and gas-inflow zones, characterization of relative fracturing
<u>SS1 Nuova Aurelia</u> Highway Tunnel, Italy	2015-2017	Single Shield TBM, Ø 13.72m, HERRENKNECHT	INTEGRAL	gneisses, amphibolites	Fault zones, fracture zones, water-bearing zones
<u>IDRIS MTS02</u> Sewerage Tunnel, Qatar	2016-2018	2 EPB-TBMs, Ø 5.85 m, HERRENKNECHT	INTEGRAL	limestones, shales, chalky limestones, Evaporites, Karst, silty clayey material	Karst and water-bearing cavities, fault zones, zones of increased porosity
<u>METRO PARIS LINE 14 LOT T01</u> France	2015 - ongoing	2 EPB-TBMs, Ø 8.9 m, HERRENKNECHT	INTEGRAL	marlstones, limestones, gypsum, sand, gravel	Karst zones, Karst cavities, and fault zones
<u>METRO PARIS LINE 14 LOT T02</u> France	2015 - ongoing	1 EPB-TBMs, Ø 8.96 m, NFM TECHNOLOGIES	INTEGRAL	marlstones, limestones, gypsum, sand, gravel	Karst zones, Karst cavities, and fault zones
<u>METRO RIYADH LINE 5,</u> Saudi Arabia	2015 - ongoing	2 EPB-TBMs, Ø 9.73 m, HERRENKNECHT	SCAN	limestone formation of different karstification grades partly brecciated	Karst zones, air-filled/water-bearing cavities, fault zones, zones of increased porosity



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<u>METRO RIYADH LINE 3,</u> Saudi Arabia	2015 - ongoing	1 EPB-TBM, Ø 10.16 m, NFM TECHNOLOGIES	INTEGRAL	limestone formation of different karstification grades partly brecciated	Karst zones, air-filled/water-bearing cavities, fault zones, zones of increased porosity
<u>AZAD WATER CONVEYANCE TUNNEL,</u> Iran	2015 - ongoing	1 EPB-TBM, Ø 3.71 m, HERRENKNECHT	INTEGRAL	conglomerates, sandstones and mudstones, limestones, shales	Fault and fracture zones
<u>METRO DOHA Gold Line,</u> Qatar	2014 - ongoing	6 EPB-TBMs, Ø 7.05 m, HERRENKNECHT	SCAN	limestones, shales, chalky limestones, Evaporites, Karst, silty clayey material	Karst and water-bearing cavities, fault zones, zones of increased porosity
<u>METRO DOHA Red Line North,</u> Qatar	2014 - ongoing	4 EPB-TBMs, Ø 7.05 m, HERRENKNECHT	INTEGRAL/ SCAN	limestones, shales, chalky limestones, Evaporites, Karst, silty clayey material	Karst and water-bearing cavities, fault zones, zones of increased porosity
<u>METRO DOHA Green Line,</u> Qatar	2014 - ongoing	6 EPB-TBMs, Ø 7.05 m, HERRENKNECHT	SCAN	limestones, shales, chalky limestones, Evaporites, Karst, silty clayey material	Karst and water-bearing cavities, fault zones, zones of increased porosity
<u>HEADRACE TUNNEL PROJECTS PANDO,</u> Panama	2014-2015	EPB-TBMs, Ø 3.78 m, LOVAT	INTEGRAL	lahars formation, pyroclastis	differentiation between clay and debris, fault zones and water-bearing zones
<u>ABU HAMOUR DRAINAGE TUNNEL,</u> Qatar	2014-2015	2 EPB-TBMs, Ø 4.52 m, HERRENKNECHT	INTEGRAL	limestones, shales, chalky limestones, Evaporites, Karst, silty clayey material	Karst and water-bearing cavities, fault zones, zones of increased permeability



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<u>STEP DEEP TUNNEL SEWER - T03,</u> United Arab Emirates (UAE)	2012	2 EPB-TBMs, Ø 6.34 m, HERRENKNECHT	INTEGRAL	dolomitic claystones and siltstones, gypsum, clay, silt	water-bearing cavities, zones of increased permeability
<u>GALLERIA MACUGNAGA,</u> Highway Pilottunnel, Alps, Italy	2012	Hard Rock GripperTBM, Ø 3.60 m	INTEGRAL	mica schists	fault zones, weathered mica schists
<u>GALLERIA SPARVO,</u> Highway Bologna-Florence, Italy	2011-2012	EPB-TBM, Ø 15.55 m, HERRENKNECHT	SCAN	unconsolidated weathered complex ophiolitic geology	fault zones, differentiation between arenitic and argillitic/pelitic lithology
<u>STEP DEEP TUNNEL SEWER - T02,</u> United Arab Emirates (UAE)	2011-2012	3 EPB-TBMs, Ø 6.34 m, HERRENKNECHT	SCAN	dolomitic claystones and siltstones, gypsum, clay, silt	water-bearing cavities, zones of increased permeability
<u>METRO ROMA LINEA C, T4</u> Italy	2010-2011	2 EPB-TBMs, Ø 6.7 m, HERRENKNECHT	SCAN	gravel, clay, silt, silty clay, pyroclastics	cavities and archeological remains ahead and around of face
<u>GASTAU Gaspipe Project,</u> Brazil	2009-2011	DS-GRIPPER TBM, Ø 6.3 m, WIRTH	INTEGRAL	gneisses, granites, diabas dykes	subhorizontal and subvertical water- bearing fault and fracture zones
<u>TARRASA UTE Railway Project,</u> Spain	2009	EPB-TBM, Ø 6.4 m, LOVAT	INTEGRAL	clay/silt, silty gravel sand/gravel, clayey carbonates, karst structures	(reinforced) concrete structures of old foundations and water wells linings, structures of Karst and old piles



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<u>Brenner Base Tunnel,</u> Austria - Italy	2008-2010	DS-TBM, Ø 6.3 m, WIRTH	INTEGRAL	granites, gneisses	fault zones
<u>METRO ROMA LINEA C, T5,</u> Italy	2009-2010	2 EPB-TBMs, Ø 6.7 m, HERRENKNECHT	SCAN	gravel, clay, silt, silty clay, pyroclastics	cavities and archeological remains ahead and around of face
<u>METRO ROMA LINEA C, T6A,</u> Italy	2008-2009	2 EPB-TBMs, Ø 6.7 m, HERRENKNECHT	SCAN	gravel, clay, silt, silty clay, pyroclastics	cavities and archeological remains ahead and around of face
<u>Blessberg Tunnel, Germany</u> (Erfurt - Nuremberg)	2008	Perimeter exploration in an existing tunnel	PERIMETER	limestones	karst cavities, open air-filled and filled with sand, gravel
<u>METRO NAPOLI LINEA 1,</u> Italy	2008	S-TBM, Ø 6.7 m, HERRENKNECHT	INTEGRAL	tuff	old-mine cavities
<u>TÚNEL DE LA CABRERA, Spain</u> (Valencia-Madrid)	2007-2008	DS-TBM, Ø 9.5 m, HERRENKNECHT	SCAN, INTEGRAL	limestones and dolomites	water-bearing fault/ karst zones and cavities
<u>METRO NAPOLI LINEA 1,</u> Italy	2007	S-TBM, Ø 6.7 m, HERRENKNECHT	INTEGRAL	tuff	old-mine cavities



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<u>VAL PASSIRIA Project,</u> Italy	2007-2008	DS-TBM, Ø 3.7 m, WIRTH	INTEGRAL	gneisses	water-bearing fault zones
<u>Proyecto del Emisario Submarino de Berria,</u> Spain	2006-2007	Micro-TBM AVN2000D, Ø 2.0 m, HERRENKNECHT	INTEGRAL	limestones	karst cavities
<u>BELES Multipurpose Project,</u> Ethiopia	2006-2008	DSU-EPB-TBM, Ø 8.1 m, SELI	INTEGRAL	volcanic rock, pyroclastics, various kind of basalt, lacustrine sediments	water-bearing fault zones, disintegrated weathering zones, silty areas
<u>CANADA LINE, Canada</u> (Vancouver - Int. Airport Vancouver)	2006-2007	EPB-TBM, Ø 6.1 m, LOVAT	INTEGRAL	sandstone, till, clayey sandy silt, coarse sand, siltstone	transition zones between sandstone and till, water-bearing formations
<u>Water Supply Tunnel TBM 1 + 3,</u> China	2006	Gripper TBM, Ø 8.3 m, ROBBINS	INTEGRAL	volcanics, metamorphics, marbles	karst cavities and fault zones with potential water-inrush zones
<u>PAJARES Tunnels Lot 1, Spain</u> (León-Asturias)	2006	2 DS-TBM, Ø 9.9 m, HERRENKNECHT and NFM	INTEGRAL	folded and faulted schistes, grey waxes and karstic limestones	water-bearing fault/ karst zones and cavities
<u>Headrace Tunnel,</u> China	2006	Boring jumbo Drill + Blast	D+B- SCAN	volcanics, metamorphics, marbles	karst cavities and fault zones with potential water-inrush zones



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<u>Jin Ping II Hydropower Project, China</u>	2006	Boring jumbo Drill + Blast	D+B- SCAN	marbles, schistes	water- and air-/gas-filled caverns
<u>ABDALAJIS Tunnel West, Spain (Malaga-Cordoba)</u>	2004-2005	Double-shield TBM, Ø 10.2 m, MITSUBISHI/ ROBBINS	INTEGRAL	clay-/siltstones, limestones, marls, dolomites	weak claystones, karst structures, water- and gas-filled cavities and fault zones
<u>Metro Barcelona Linea 9, Spain</u>	2004-2005	Dual Rock-Soil TBM, Ø 11.95 m, WIRTH/ NFM	INTEGRAL	granite, discomposed granite (sand, gravel and boulders)	fault and fracture zones, (thermal) water-bearing zones
<u>PRISNIG Tunnel, Italy</u>	2004-2005	Open type TBM, Ø 5.80 m, JARVA	INTEGRAL	calcareous and anhydrite/ gypsum formations	fault/ karst zones and caverns
<u>Guadarrama North-Tunnel, Spain (Madrid-Segovia)</u>	2004	Double-shield TBM, Ø 9.51 m, HERRENKNECHT	INTEGRAL	gneisses and intrusive rocks of granitoid type	finegrained (mylonitic) shear zones
<u>GOTTHARD Base Tunnel, South Portal, Switzerland</u>	2003-2004	2 Gripper TBMs, Ø 9.51 m, HERRENKNECHT	INTEGRAL	gneisses	subhorizontal and subvertical water- bearing fault and fracture zones
<u>GOTTHARD Base Tunnel, Section Sedrun, Switzerland</u>	2003	Drill & Blast	D+B- SCAN	schists and gneisses	water-bearing fault zones



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<u>Stammham Tunnel, Germany</u> (Nuremberg – Ingolstadt)	2002-2003	Perimeter exploration in existing tunnel	PERIMETER	limestones and dolomite	karst cavities, open air-filled and filled with sand, gravel
<u>Geisberg Tunnel, Germany</u> (Nuremberg – Ingolstadt)	2002-2003	Perimeter exploration in existing tunnel	PERIMETER	limestones and dolomite	karst cavities, open air-filled and filled with sand, gravel
<u>GINORI Tunnel, Italy</u> (Florence-Bologna)	2000-2003	Telescopic-shield TBM, Ø 6.3 m, WIRTH	SCAN	limestones	high water-bearing and high permeability subvertical karst and fault zones
<u>Irlahuell Tunnel, Germany</u> (Nuremberg – Ingolstadt)	2000-2003	Perimeter exploration in existing tunnel	PERIMETER	limestones and dolomite	karst cavities, open air-filled and filled with sand, gravel
<u>Loetschberg Base Tunnel,</u> Switzerland	2000	Drill & Blast Boring jumbo	D+B- SCAN	schists, marls and limestone	karst-structures and clayey schist shear zones