The Microbial Impact on Cellulose Hydrolysis in a Cementitious Geological Disposal Facility

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Study microbes in a GDF

- Cellulose Degradation

Table 9: Mass of materials by waste category

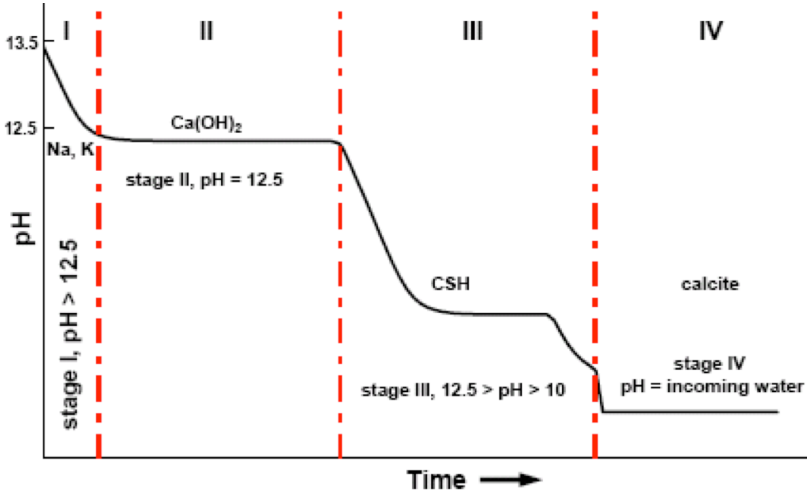
Material	Mass (tonnes) HLW	ILW	LLW	VLLW
Metals:				
Stainless steel	1.9	28,000	150,000	8.2
Other steel	-	32,000	370,000	1,100
Iron	-	3,200	37,000	4,300
Magnox/magnesium	-	6,500	130	0.11
Aluminium	-	1,900	19,000	8.1
Zircaloy/zirconium	-	1,300	240	0.11
Copper & alloys	-	300	13,000	440
Nickel & alloys	21	88	1,100	-
Uranium	-	1,000	970	55.0
Other metals	-	1,400	41,000	140,000
Organics:				
Cellulosics	-	1,200	68,000	41,000
Plastics	-	4,600	89,000	830
Rubbers	-	1,100	16,000	210
Ion exchange resins	-	430	200	-
Hydrocarbons	-	46	8,100	1,100
Other organics	-	370	31,000	19,000
Inorganics:				
Asbestos	-	66	22,000	28,000
Cementitious materials	-	64,000	780,000	2,100,000
Graphite	-	82,000	15,000	-
Sand, glass & ceramics	2,700	1,200	20,000	150
Ion exchange materials	-	3,200	74	-
Brick, stone & rubble	-	1,100	77,000	430,000
Sludges, flocculants & liquids	490	31,000	12,000	2.4
Other inorganics	-	1,200	340	27,000
Soil	-	150	92,000	140,000
Unspecified materials[1]	0	8,700	12,000	220
TOTAL	**3,200**	**280,000**	**1,900,000**	**2,900,000**

✱ Higher activity wastes (HLW, ILW) and some LLW unsuitable for near-surface disposal are being accumulated in stores.

Experimental and Theoretical Studies on Alkaline Degradation of Cellulose and its Impact on the Sorption of Radionuclides

L.R. Van Loon and M.A. Glaus

Component	Concentration (mM)	% of DOC
DOC	317	100
alkali extractable DOC	16.6	5.2
[1]Oxalic acid	n.m.	-
[1]Formic acid	3.9	1.2
[1]Acetic acid	2.3	1.5
[1]Glycollic acid	1.1	1.0
[1]Lactic acid	1.9	0.9
[1]Succinic acid	0.1	0.1
[2]α-Isosaccharinic acid	24.5	46
[2]β-Isosaccharinic acid	20.3	39



Complex & mobilise radionuclides:

- Eu(III) (Vercammen et al. 2001)
- Am(III) (Tits at al. 2005)
- Th(IV) (Wieland et al. 2002)
- Np(IV) (Rai et al. 2003)
- U(IV) (Warwick et al. 2004)

Can Microbes mitigate this enhanced radionuclide mobility?

Microbial Cellulose Degradation

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Mineralogical Magazine, November 2015, Vol. 79(6), pp. 1433–1441

OPEN ACCESS

Microbial degradation of cellulosic material under intermediate-level waste simulated conditions

Naji M. Bassil[1,2], Alastair D. Bewsher[1], Olivia R. Thompson[3] and Jonathan R. Lloyd[1,*]

OXFORD FEMS

FEMS Microbiology Ecology, 96, 2020, fiaa102

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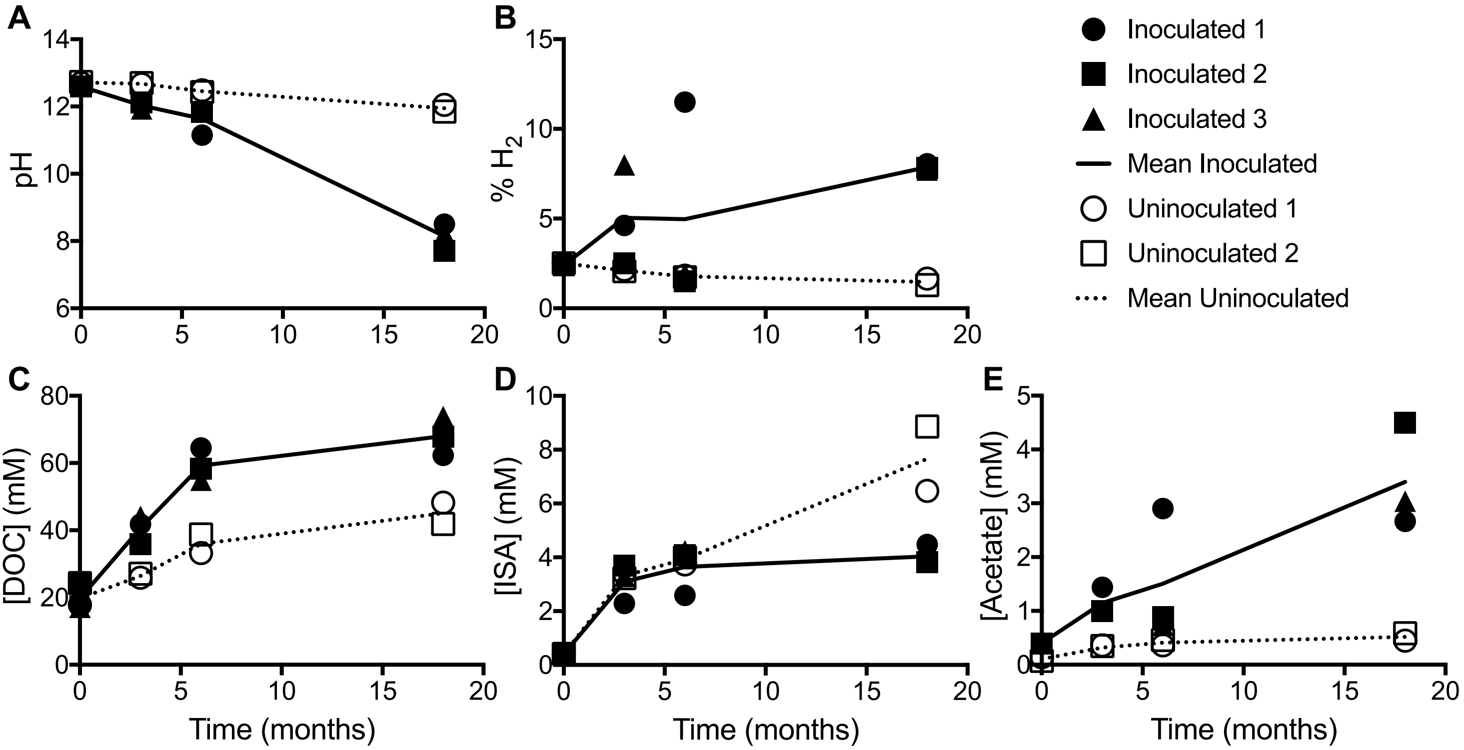
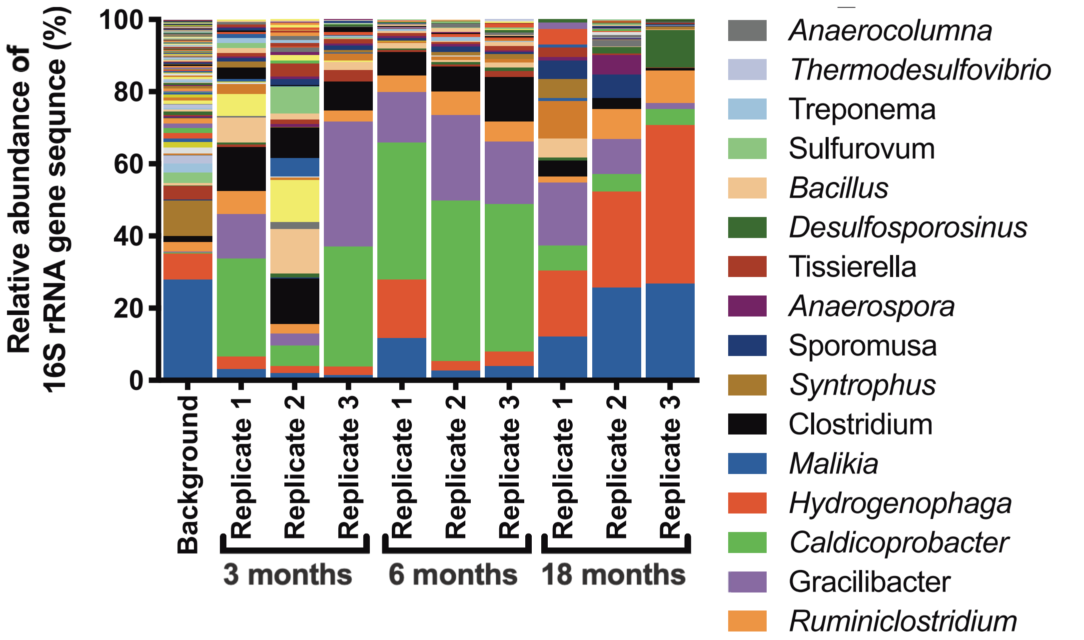
Advance Access Publication Date: 27 May 2020
Research Article

RESEARCH ARTICLE

Enhanced microbial degradation of irradiated cellulose under hyperalkaline conditions

Naji M. Bassil[1,2,*,†], Joe S. Small[1,3] and Jonathan R. Lloyd[1,2]





Microbial ISA Degradation

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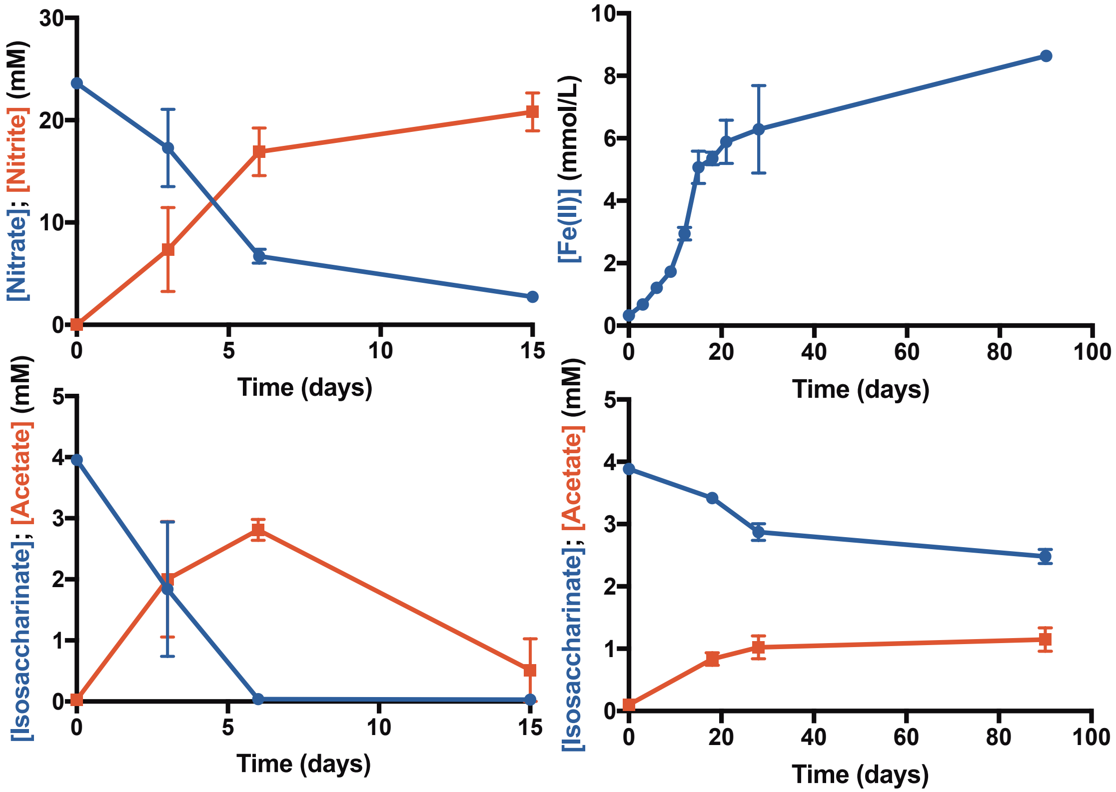
The ISME Journal (2015) 9, 310–320

www.nature.com/ismej

ORIGINAL ARTICLE

Microbial degradation of isosaccharinic acid at high pH

Naji M Bassil[1,2], Nicholas Bryan[3] and Jonathan R Lloyd[1]



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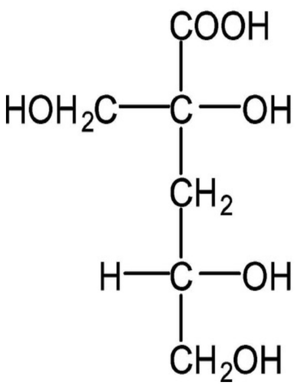

ISA

Mineralogical Magazine, November 2015, Vol. 79(6), pp. 1443–1454

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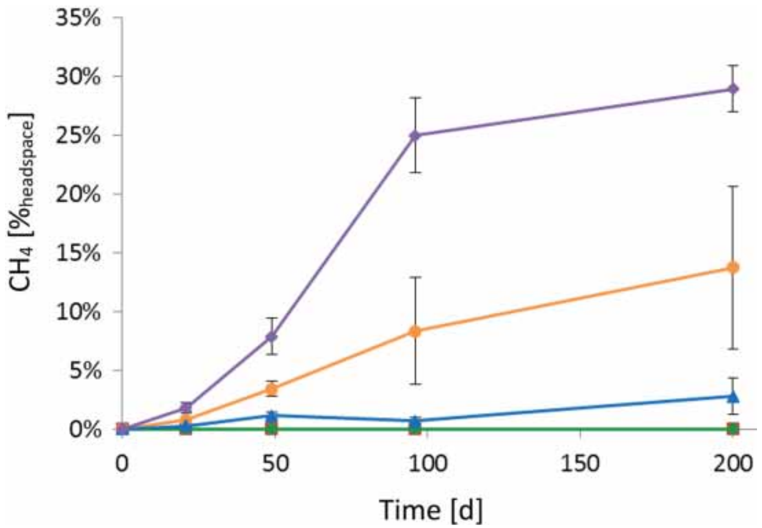
Microbial degradation of isosaccharinic acid under conditions representative for the far field of radioactive waste disposal facilities

Gina Kuippers[1,*], Naji Milad Bassil[1], Christopher Boothman[1], Nicholas Bryan[2] and Jonathan R. Lloyd[1]



OPEN ACCESS Freely available online PLOS ONE

Biodegradation of the Alkaline Cellulose Degradation Products Generated during Radioactive Waste Disposal

Simon P. Rout, Jessica Radford, Andrew P. Laws, Francis Sweeney, Ahmed Elmekawy, Lisa J. Gillie, Paul N. Humphreys*

Anoxic Biodegradation of Isosaccharinic Acids at Alkaline pH by Natural Microbial Communities

Simon P. Rout[1], Christopher J. Charles[1], Charalampos Doulgeris[1], Alan J. McCarthy[2], Dave J. Rooks[2], J. Paul Loughnane[2], Andrew P. Laws[1], Paul N. Humphreys[1]*

A. isosaccharinicus

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INTERNATIONAL JOURNAL OF SYSTEMATIC AND EVOLUTIONARY MICROBIOLOGY

TAXONOMIC DESCRIPTION
Bassil and Lloyd, *Int J Syst Evol Microbiol*
DOI 10.1099/ijsem.0.002721

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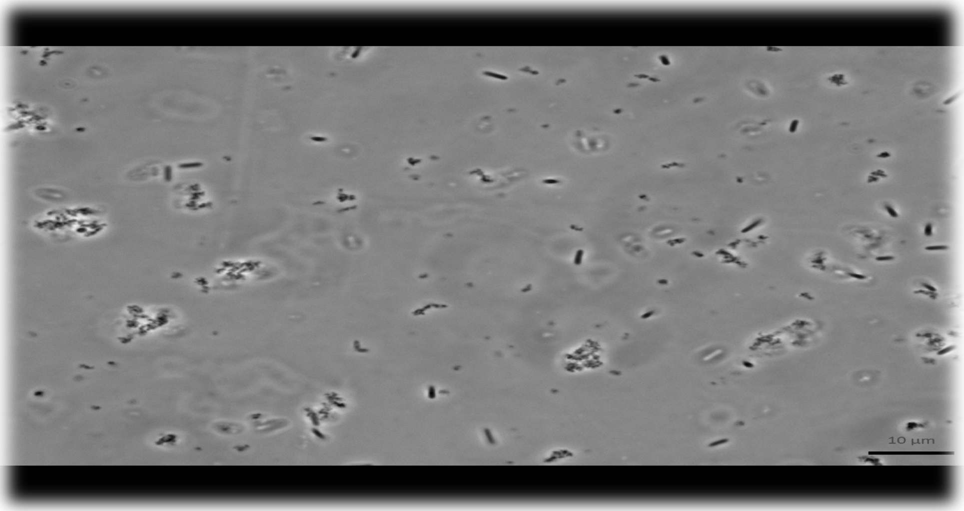
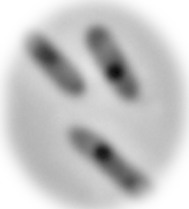
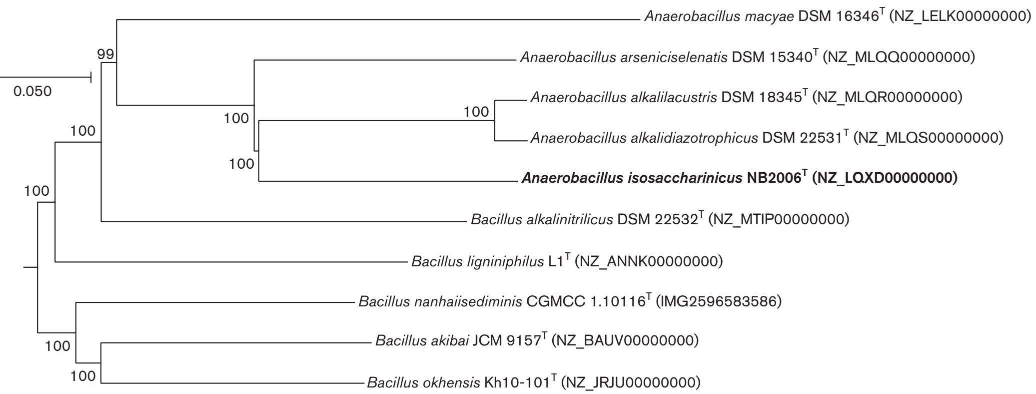
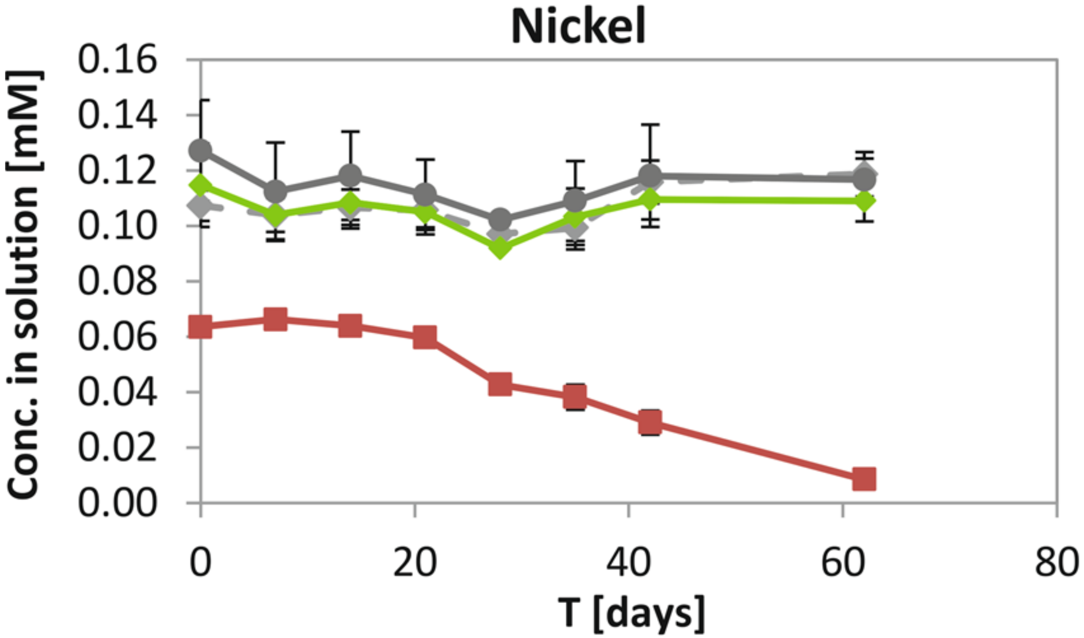
Anaerobacillus isosaccharinicus sp. nov., an alkaliphilic bacterium which degrades isosaccharinic acid

Naji M. Bassil* and Jonathan R. Lloyd









The biogeochemical fate of nickel during microbial ISA degradation; implications for nuclear waste disposal

Gina Kuippers[1], Christopher Boothman[1], Heath Bagshaw[1], Michael Ward[2], Rebecca Beard[3,5], Nicholas Bryan[4] & Jonathan R. Lloyd[1]

Conclusion & Future Work

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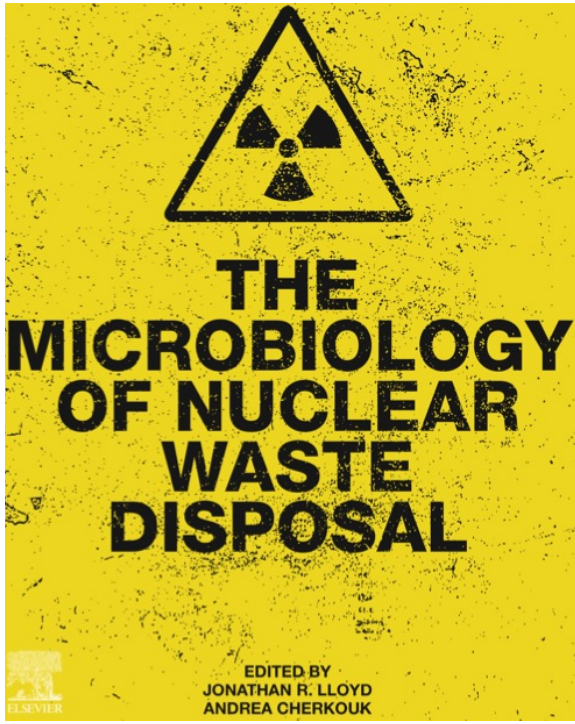
- Microbes are present and active in the subsurface
- Studies support the Bio-Barrier concept
  - Microbial cellulose degradation under hyperalkaline conditions
  - Microbial ISA degradation under GDF-relevant conditions
  - Metals immobilisation
- “Microbes are doing things we didn’t know they could do 10 years ago” Robert H. Jackson



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