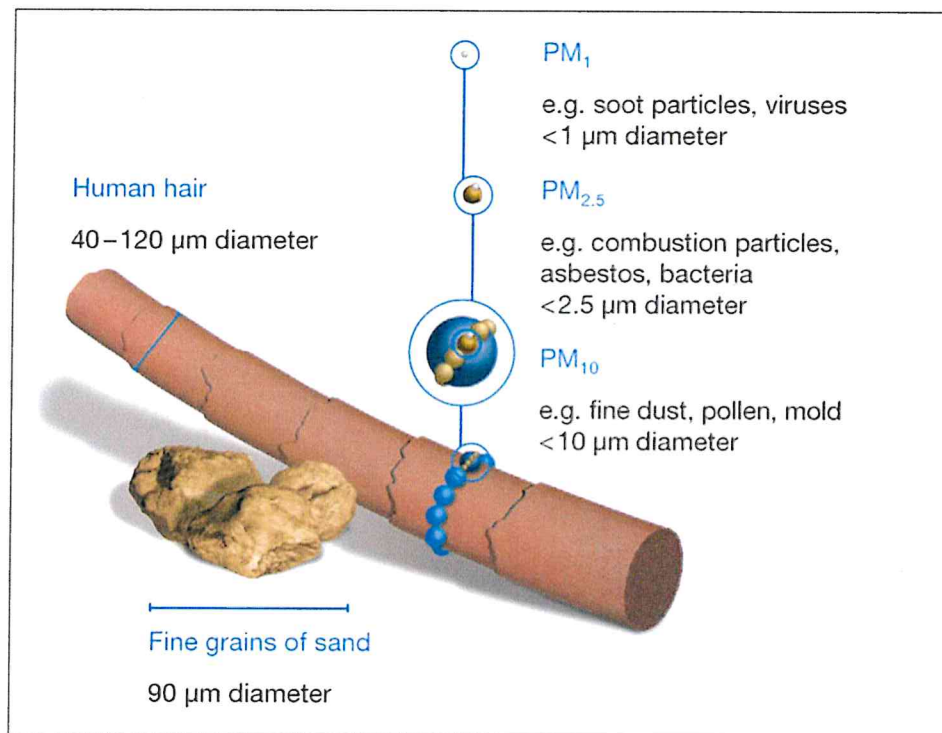




Støvpartikler:

Klassificering af støvpartikler til TSP, PM₁₀, PM_{2,5} og PM_{1,0}:



Billede 1. Illustration af støvpartikler: PM₁₀, PM_{2,5} og PM_{1,0}.¹

TSP er støvpartikel, med diameter på mindre eller lig med 40 µm (microns), kan f.eks mærkes med tungen, når den kommer i munden. PM₁₀ 's diameter er mindre end eller lig med 10 µm, kan akkurat føles med fingerspidserne, som meget meget fint støv. PM_{2,5} 's diameter er mindre end eller lig med 2,5 µm, kan akkurat føles med fingerspidserne, som meget meget fint støvpartikel. PM_{1,0} 's diameter er mindre eller lig med 1 µm, de er så små at de ikke kan ses og mærkes.²

Og når man sprænger klipper, f.eks. på en åben mine, når de mindste støvpartikler højest i støvskyen.

Støvpartiklerne PM₁₀, PM_{2,5} og PM_{1,0} er indhalerbare, og kommer ind i menneskets krop gennem indånding. Og de er sundhedsskadelige, fordi de har større overfladeareal end de større partikler. Hvis man smadrer en bowlingkugle, kommer der mange stumper som får større overfladeareal. Jo mindre støvpartikler er, jo farligere er de. F.eks. 10 gram TSP sammenlignet med 10 gram PM_{2,5}. Her er PM_{2,5} meget farligere end TSP p.g.a. større overfladeareal.

¹ Air Particulate Monitoring – PM₁, Kruti Davda (2020), <https://oizom.com/knowledge-bank/air-particulate-monitoring/>

² National ambient air quality objectives for particulate matter, Health Canada, Environment Canada (1998)



Støvpartiklerne $PM_{2.5}$ og $PM_{1.0}$ er så små, at de også kan komme ind i mennesket krop gennem hårrødderne og huden.³ Og på den måde spredes de i kroppen via blodcirkulationen.⁴

Luftbårne støvpartikler.

Table 1: Comparison of the basic properties of fine vs course PM.

Characteristics	Fine fraction ($PM_{2.5}$)	Coarse fraction (PM_{10})
Composition	Sulphate SO_{2-4} , nitrate NO_3 , ammonium NH_4 , hydrogen ion H^+ , elemental carbon C, organic compounds, PAH metals Pb, Cd, V, Ni, Cu, Zn, particle-bound water, biogenic organics.	Resuspended dust, soil and street dust, coal and oil fly ash, metal oxides of Si, Al, Mg, Ti, Fe, $CaCO_3$, NaCl, sea salt, pollen, mold spores, plant parts.
Sources	Combustion of coal, oil, gasoline, transformation products of NO_x , SO_2 , and organic including biogenic organics, high temperature processes, smelters, and steel mills.	Resuspension of soil tracked onto roads and streets, suspension from disturbed soils, resuspension of industrial dust, construction, coal and oil combustion, and ocean spray.
Lifetimes	Days to weeks	Minutes to hours
Travel distance (km)	100 to 1000	1 to 10

Tabel 1.⁵ NB! $PM_{1.0}$ er ikke med i tabellen, fordi man er i gang med forske dem nærmere. Men man skal regne at, de når meget længere end de større støvpartikler.

Støvpartiklerne er så små, at de bliver luftbårne, hvor de kommer ind i vandpartikler (luftfugtighed). Og de bliver i luften i lang tid og bliver blæst rundt med vinden og når meget lange afstande.

Støvets påvirkning af menneskets helbred.

Videnskabet af støvpartiklers påvirkninger af menneskets helbred er blevet intensiveret gennem de sidste årti. Mange lande har lavet kriterier for luftkvaliteten for civilbefolkningen. Der er indført kriterier for støvpartiklerne TSP, PM_{10} og $PM_{2.5}$. Men ikke for $PM_{1.0}$ endnu. Men der er ingen tvivl om, at kriterier for $PM_{1.0}$ kommer forhåbentligt meget snart, p.g.a. deres farlighed for menneskets helbred.

³ Impact of airborne particulate matter on skin: a systematic review from epidemiology to in vitro studies, Irini M. Dijkhoff m.fl. (2020)

⁴ Effects of Inhalable Particulate Matter on Blood Coagulation, Matteo Bonzini m.fl. (2010)

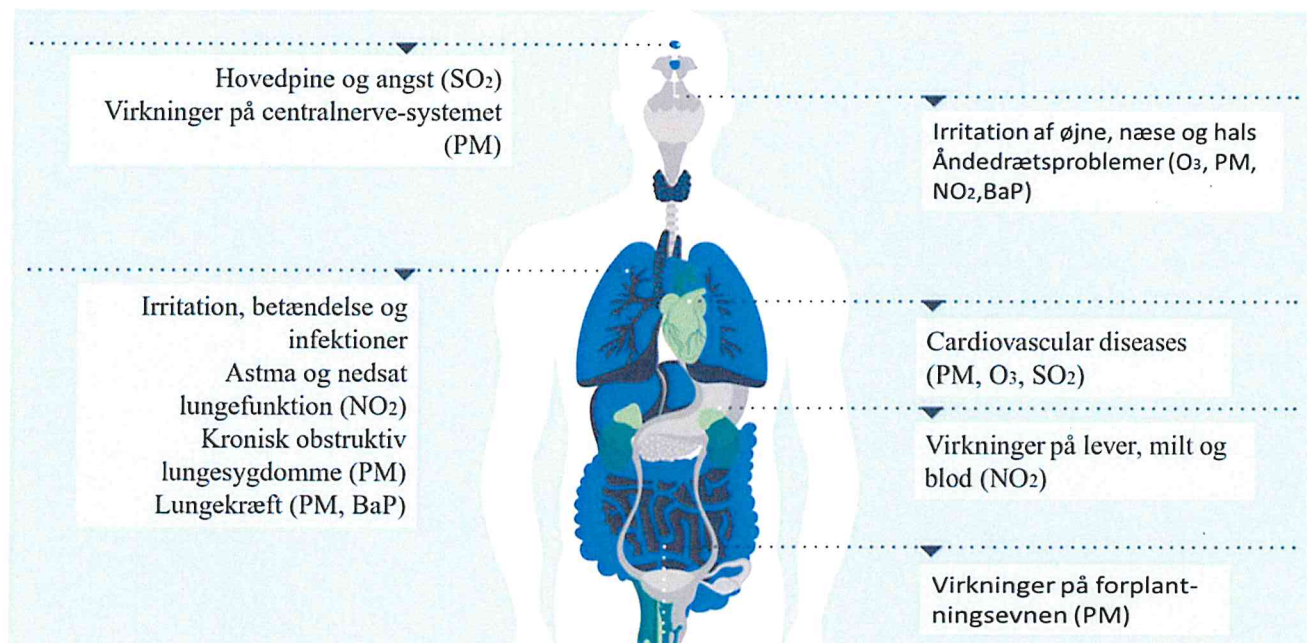
⁵ Dust production in mining. Suppression measures in quarry blasting, Gonzalo Morera De La Vall González (2018)



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Europæiske videnskabsmænd mener, at i 2012 døde 630.000 europæere på grund af luftforurening.⁶ Og man skønner, at 400.000 af dem er døde p.g.a. støvforurening.



Source: Based on EEA (2013)

Billede 2. Støvpartiklernes påvirkning af menneskets helbred.⁷

Grundstoffer og mineraler, hvor de fleste af dem er tungmetaller:

Grundstoffer, som er radioaktive og deres isotoper i Kvanefjeldet:

Uran, thorium, radium, actinium, radon, polonium, bismuth, lead, thallium, beryllium, protactinium, cerium, hafnium, mangan, niobium, tantal, francium, astat, neptunium, strontium.⁸

Sjældne mineraler:

Lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium, yttrium, scandium.⁹

Tungmetaller:

Bly, barium, arsen, kviksølv, zink, jern, aluminium, krom, silicium, rubidium, selen, vanadium, cobolt og andre over 200 forskellige mineraler.¹⁰

⁶ Healthy environment, healthy lives: how the environment influences health and well-being in Europe, European Environment Agency (2020)

⁷ Healthy environment, healthy lives: how the environment influences health and well-being in Europe, European Environment Agency (2020)

⁸ The emplacement and crystallization of the U–Th–REE-rich agpaitic and hyperagpaitic lujavrites at Kvanefjeld, Ilímaussaq alkaline complex, South Greenland, Henning Sørensen allallu (2011)

⁹ The emplacement and crystallization of the U–Th–REE-rich agpaitic and hyperagpaitic lujavrites at Kvanefjeld, Ilímaussaq alkaline complex, South Greenland, Henning Sørensen allallu (2011)

¹⁰ The emplacement and crystallization of the U–Th–REE-rich agpaitic and hyperagpaitic lujavrites at Kvanefjeld, Ilímaussaq alkaline complex, South Greenland, Henning Sørensen allallu (2011)



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“The vulnerability of children to environmental stressors. Children are more vulnerable than adults to environmental risks.

First, they breathe more air, consume more food and drink more water than adults in proportion to their weight.

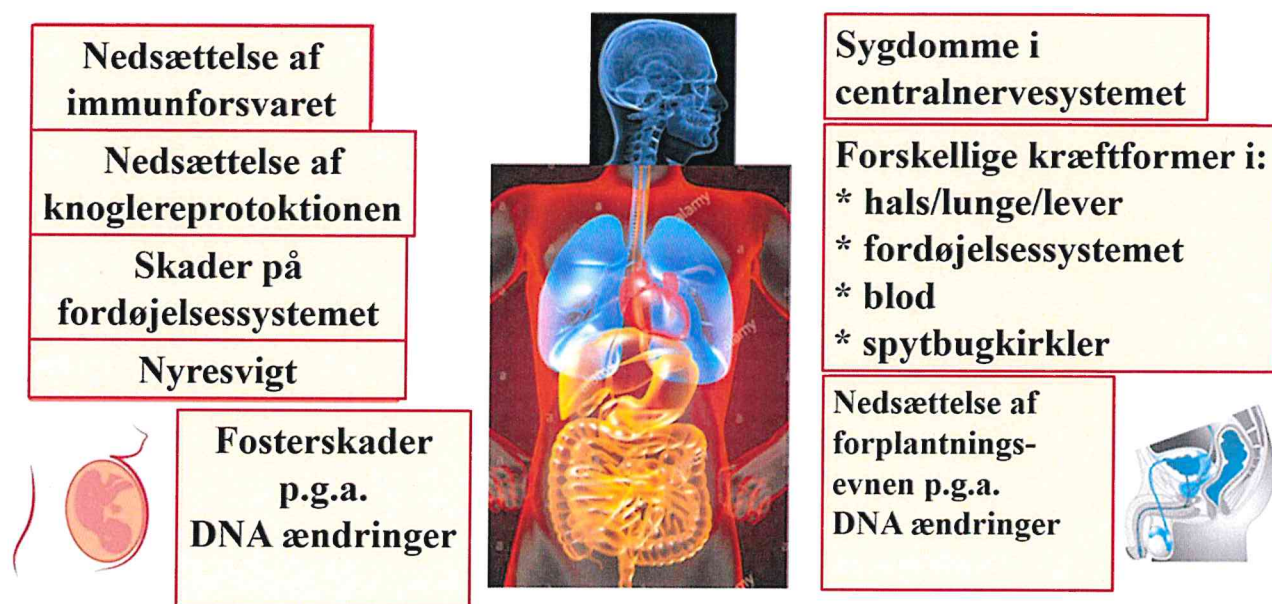
Second, the central nervous, immune, reproductive, endocrine and digestive systems of a child are still developing. During certain critical windows of vulnerability, exposure to environmental contaminants can lead to irreversible damage.

Third, children behave differently from adults and have different patterns of exposure to environmental hazards. Young children crawl on the ground and can therefore be exposed to dust and chemicals that accumulate on floors and soils.

Finally, children have little control over their environments. Unlike adults, they may be both unaware of risks and unable to make choices to protect their health. Because of these unique vulnerabilities, children need special protection from environmental hazards.”

Source: WHO (2017c).¹¹

Kort og godt børn er mere udsatte for forurening.



Billede 3. Radioaktive grundstoffer og deres isotopers virkninger på kroppen.¹²

Og vi skal og nævne, at i VVM-rapporten ikke nævnes barryliumssyge, som rammer minearbejdere og civilbefolkningen.

¹¹ Healthy environment, healthy lives: how the environment influences health and well-being in Europe, European Environment Agency (2020)

¹² Uranium mining and health, Canadian Family Physician • Le Médecin de famille canadien, Dale Dewar m.fl. (2013)



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Sprængninger af klipper i Kvanefjeldet.

Planen er, at der vil blive sprængt 6.000.000 tons klippe i Kvanefjeldet om året. Og der vil være sprængninger hver andendag. D.v.s. min. 180 sprængninger om året. I gennemsnittet vil man sprænge 33.333 tons klippe hvert gang. Og de er lig med 12.400 m³ klippe.¹³



Billede 4. Sprængning pr. gang er størrelse med Narsaq's fodboldbane og med dybden på 2 m. 96 m x 65 m x 2 meter.



Billede 5. Sprængning på åben mine og spredning af støvpartikler.

¹³ Kvanefjeld Project Environmental Impact Assessment, Greenland Minerals limited 2020.



Støvpartikler fra Kvanefjelds-projektet i Narsaq.

Følgende aktiviteter vil afgive støv i Kvanefjelds-projektet:¹⁴

1. Byggerier
2. Boringer
3. Sprængninger
4. Transport til gråbjerget og malmknuseren
5. Losning af tailings til gråbjerget og til malmknuseren
6. Knusning af malm
7. Lastning af finkornet malmmel
8. Transport mod kajen
9. Lastning af skibe
10. Røg fra skibe
11. Transport mod mineområdet
12. Transportmidlernes røg
13. Røg fra kraftværket

Og man skal regne, at der sker ulykker under transport. Og under på- og aflastning af malmmel.

I VVM- og VSB-rapporterne blev der ikke nævnt, hvor farlige støvpartiklerne er. Ej heller de mest farlige PM_{2,5} og PM_{1,0}.¹⁵

Støvemissioner med computerprogrammet CALPUFF.

CALPUFF er et computerprogram til at forudse støvpartikelspredning. Støvpartikelemissionen er baseret på 2 meters højde.¹⁶ CALPUFF er blevet testet, og man har konkluderet, at det er bedre til at forudse hvor afstanden er mere end 50 km. Men dens støvpartikelemissionsmålinger er tit for lave i forhold til virkeligheden.¹⁷

Fordelingsnøgle af støv i Kvanefjelds-projektet i Narsaq:

VVM- & VSB-rapporterne, bruges EPA's¹⁸ metode, med hensyn til støvfordeling, (grå felt): ☐
1 kg støv:

Tabel 2	TSP	PM ₁₀	PM _{2,5}	PM _{1,0}	Indhalerbare
Forholdstal	1	34,1 % af TSP	29,0 % af PM ₁₀	-	
Gram	1000	341	101	-	341

Tabel 2: Ifølge EPA's fordelingsnøgle for støv fra minedrift.

¹⁴ Air Quality Assessment – Kvanefjeld, ERM Worldwide Group Ltd (2018)

¹⁵ Kvanefjeld Project Environmental Impact Assessment, Greenland Minerals limited 2020.

¹⁶ Air Quality Assessment – Kvanefjeld, ERM Worldwide Group Ltd (2018)

¹⁷ Performance evaluation of AERMOD, CALPUFF, and legacy air dispersion models using the Winter Validation Tracer Study dataset, Arthur S. Rood (2014)

¹⁸ Air Quality Assessment – Kvanefjeld, ERM Worldwide Group Ltd (2018)

CALPUFF's støvpartikelemissioner er baseret på vindmålinger i toppen af Kvanefjedet i perioden 2010-2014, og VVM- & VSB-rapporterne konkluderer, at støvpartikler fra projektet vil ikke være sundhedsfarligt for civilbefolkningen i Narsaq og omegn.¹⁹

EPA's fordelingsnøgle for PM_{2,5}, PM₁₀ og TSP er blevet kriseret af undersøgelser baseret på 25 forskellige miner over hele kloden. Og de nævner, at forurening med støvpartikler øges med længden af minedriften. (Saironen 2018)

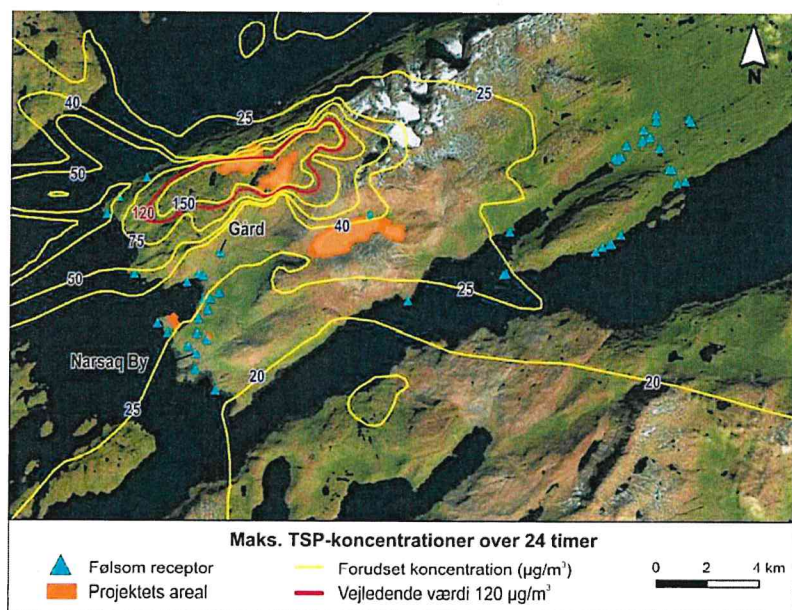
Ifølge Sairanen (2018)²⁰ burde fordelingsnøgle for PM_{2,5}, PM₁₀ og TSP anderles ud, og når man kombinerer de med Suns (Sun 2020) undersøgelser med PM_{1,0}²¹, vil vi få hel anden billede af støvpartikelfordelingen i Kvanefjeldsprojektet (gulig baggrund): 

Tabel 3	TSP	PM ₁₀	PM _{2,5}	PM _{1,0}	Indhalerbare
Forholdstal	1	34,1 % af TSP	29,0 % af PM ₁₀	-	
Gram	1000	341	101	-	341
Forholdstal	1	55,6 % af TSP	37 % af PM ₁₀	70 % af PM _{2,5}	
Gram	1000	556	185	130	556
Forskel		215	84	130	215

Tabel 3: Beregningsgrundlaget er 1 kg støvpartikler.

Andre argumenter:

Narsaq by ligger tæt på Kvanefjeldet. Afstanden er 5-6 km. Til brug af støvpartikelemissionen har man lagt følsomme receptorer i landskabet i Narsaq området:



Figur 44 Maksimale 24-timers koncentrationer af luftbårne partikler (TSP) i $\mu\text{g}/\text{m}^3$ (kumulative)

¹⁹ Air Quality Assessment – Kvanefjeld, ERM Worldwide Group Ltd (2018)

²⁰ A review of dust emission dispersions in rock aggregate and natural stone quarries, Marjo Sairanen m.fl. (2018)

²¹ Chemical Differences Between PM₁ and PM_{2.5} in Highly Polluted Environment and Implications in Air Pollution Studies, Yele Sun et al. (2020)



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Billede 6. Bemærk følsomme receptors placeringer.²²

Beskyttelsesværdige er prioriteret:

- fire steder i Narsaq
- gården i Narsaq-dalen
- fem sommerhuse i Narsaq-dalen
- stedet for den foreslåede landsby
- 45 arkæologiske steder og
- grostedet for den sårbare rundbladede rhizomgøgeurt (*Amerorchis rotundifolia*).

²² Kvanefjeld Project Environmental Impact Assessment, Greenland Minerals limited 2020.



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I Denver, i USA, har man lagt følsomme receptorer systematisk . (Se billede 7).

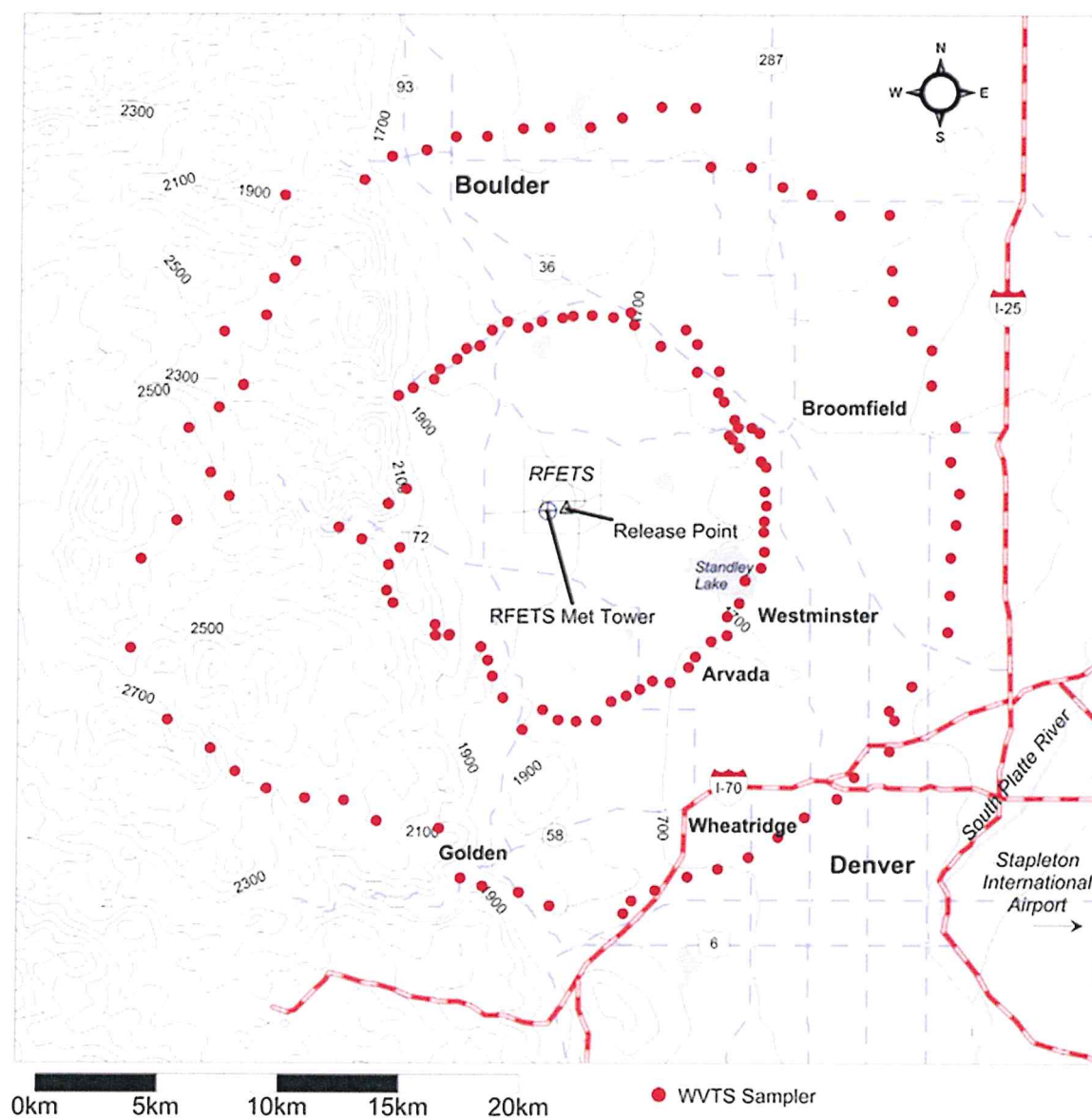
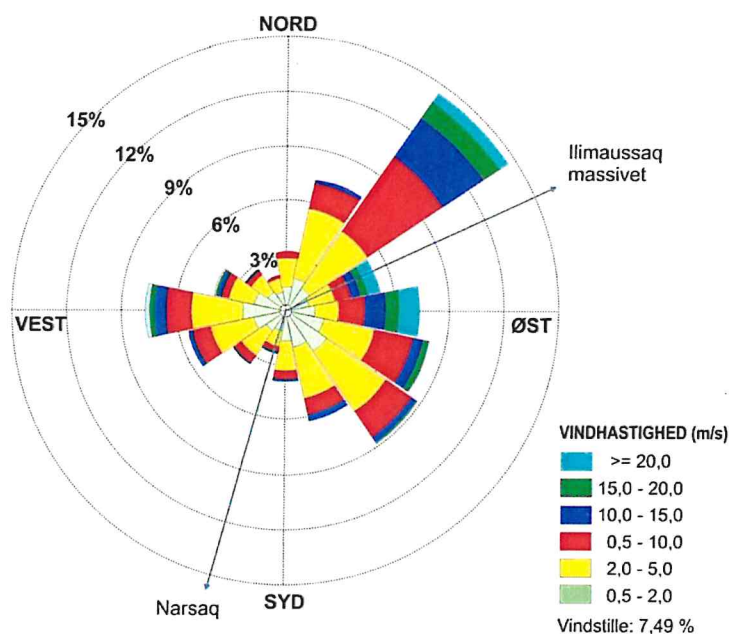


Fig. 1. CALPUFF model domain showing location of the WVTs samplers and terrain features of the Colorado Front Range.

Billede 7. Fra: Performance evaluation of AERMOD, CALPUFF, and legacy air dispersion models using the Winter Validation Tracer Study dataset Arthur S. Rood 2013-14



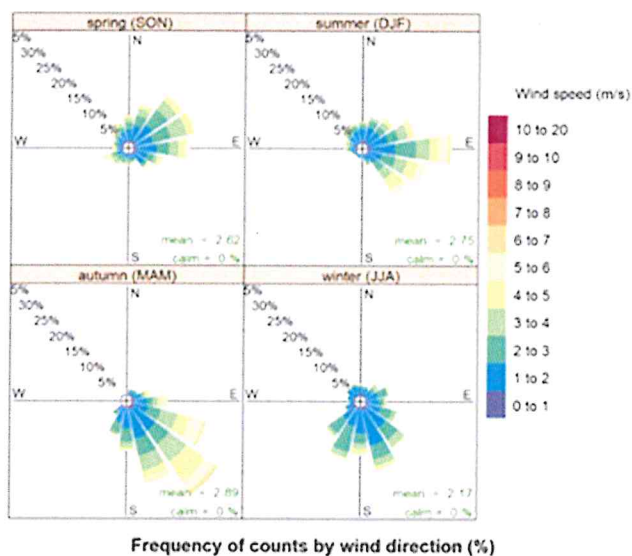
I VVM- og VSB-rapporterne vises vejrforholdene i årene 2010-2013 fra én ubemandet vejrstation, som var placeret på toppen af Kvanefjeldet. Afstand til Narsaq by 5-6 km:



Figur 35 Vindretninger og vindhastigheder registreret af Kvanefjeld vejrstation

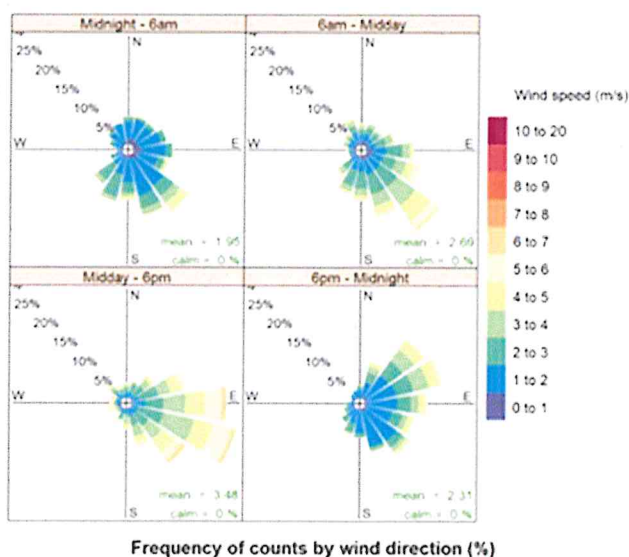
Billede 8: Gennemsnitslige vindretninger og vindhastigheder i Kvanefjeldet 2010-2014.

I Australien har Vitrinite Pty Ltd søgt om, at åbne en kulmine.²³ Og de har været påpasselige med grafer med vindretninger og vindhastigheder. Grunden er kulminen ville lægge mellem to byer. Moranbah med 9.000 indbyggere, som er 30 km sydligt fra kulmineprojektet og Dysart med 3.000 indbyggere, som ligger 35 km fra kulmineprojektet.



Seasonal wind roses for the VCP site (extracted from CALMET) - 2018

Billede 9. Årstidsfordelt.



Diurnal wind roses for the VCP site (extracted from CALMET) - 2018

Billede 10. Timefordelt.

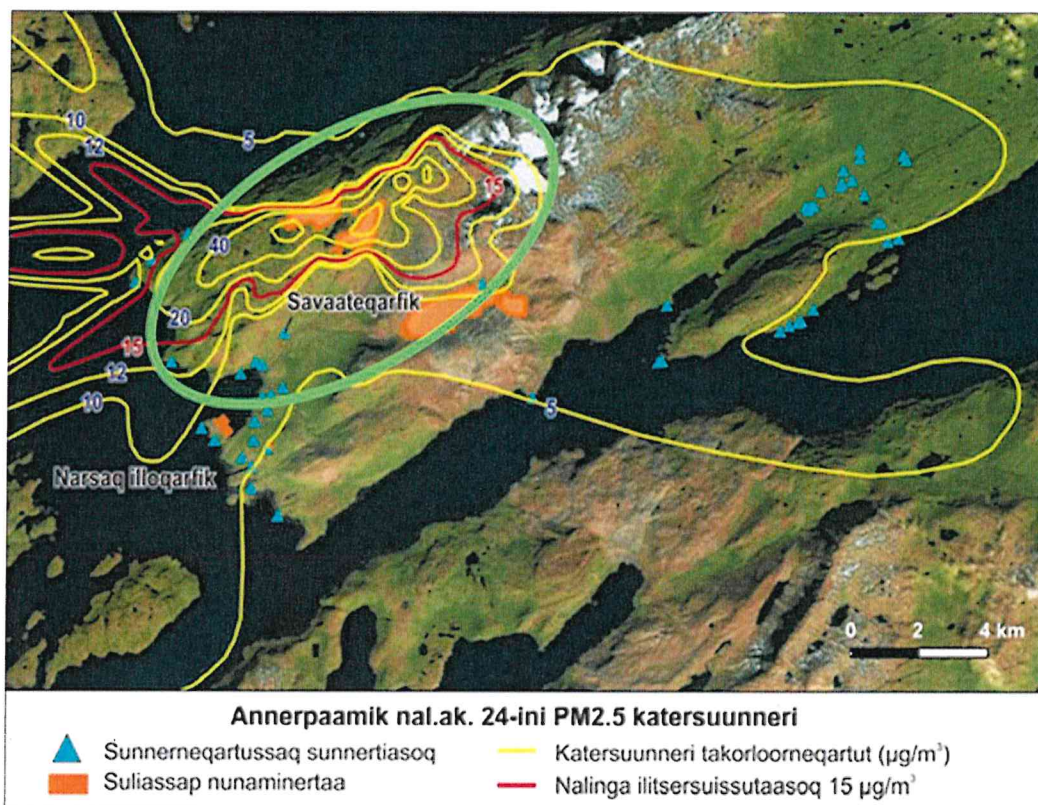
²³ Vulcan Complex Project Air Quality Assessment, Simon Welchman (2020)



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Langs fjeldskråningerne i Narsap Ilua vises, at det vil blæse opad i støvpartikelemissionerne i Kvanefjeldsprojektet.



Billede 11. Bemærk: Vinden blæser opad langs fjeldskråningerne.

Gryning og Lyck foretog meteorologiske observationer i Narsap Ilua i 1983. De undrede sig over dræningsvinde om vinteren. Dræningsvindene blæste nedad fjeldene. Og i Narsaq kaldes vinden "aqqarsarneq" "den nedadgående blæst". Det andet de undrede sig over er at vinden i dalen skifter retning med 180° hver halve time.²⁴

Ifølge VVM- og VSB-rapporterne skal støvpartiklerne bekæmpes med tågekanoner om sommeren. De regner ikke med, at bekæmpe det hele. Om kolde perioden kan støvet ikke bekæmpes med tågekanoner.²⁵

²⁴ Preliminary Environmental Impact Statement for the Kvanefjeld Uranium Mine, Kim Pilegaard (1990)

²⁵ Kvanefjeld Project Environmental Impact Assessment, Greenland Minerals limited 2020.



Vi kræver på det kraftigste , at:

- Grunden til vores kraftigste krav er, at Kuannersuit ligger tæt på byer, fåreholdersteder, rensdyravlsteder, kvægavlsteder, havebrug, græsningsmarker, græsningsarealer til avlsdyr og fiske- og fangststeder (se tabel 1) . Støvpartikelforurening vil ramme alle levende, og påvirke negativ på deres sundhed: Civilbefolkning, dyr, fugle, fisk, insekter og planter. Og man vil ødelægge samspil mellem de levende organismer, det vil sige hele biodiversitetet.

Vejrforholdene er ændret sig siden 2010-2013. På grund af klimaforandringer kommer der flere kraftige storme. Om vinteren har vi stærk nordenvind, specielt efter af piteraq i Østgrønland. Om sommeren er der tit vestenvind.

1. Der er kommet ny viden omkring støvpartikler på det seneste tid. Derfor kræver vi, at støvpartiklernes, TSP : PM₁₀ : PM_{2,5} : PM_{1,0}'s, forholdstal 1 : 0,556 : 0,185 : 0,130. benyttes til en ny støvemission på baggrund af Sairanens (2018) og Suns undersøgelser (2020). Endvidere kræver vi, at luftkvaliteten i Narsaq by undersøges, fordi nuværende støvpartikelaktivitet skal lægges oveni mines støvpartikelaktivitet.

2. Vi kræver på det kraftigste, at støvets sammensætning af grundstoffer og deres isotoper analyseres og fremlægges, fordi **de fleste af grundstofferne er tungmetaller, som ikke kan nedbrydes og som er meget sundhedsskadelige:**

20 radioaktive grundstoffer og deres isotoper:

Uran, thorium , radium, actinium, radon, polonium, bismuth, thallium, beryllium, protactinium, cerium, hafnium, mangan, niobium, tantal, francium, astat, neptunium, strontium.

Sjældne mineraler:

Lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium, yttrium, scandium.

Andre grundstoffer:

Flour, bly, barium, arsen, kviksølv, zink, jern, aluminium, krom, silicium, rubidium, selen, vanadium, cobolt og andre grundstoffer og mineraler på over 200.

3. Andre støvekspertes skal undersøge "Air Quality Assessment – Kvanefjeld, ERM Worldwide Group Ltd (2018)", for deres forudsigelser for støvpartikelaktivitetet i Kvanefjeldsprojektet.

4. Vi kræver oplysninger på borestørrelse og boreddybder. For de er vigtige oplysninger for hvor højt støvpartiklerne kommer op i luften, når der sprænges.²⁶

²⁶ Sikkerhedsanvisninger ved sprængningsarbejder, DSF (2017)

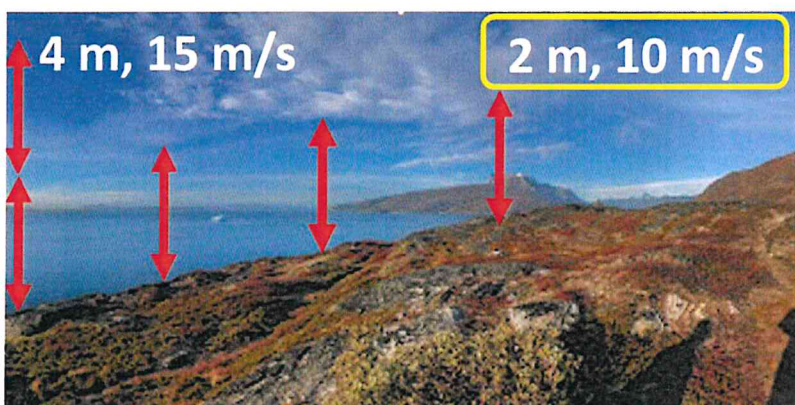


5. Vi kræver, at mikrometeorologien i Narsap Iluata's dal undersøges (Gryning og Lyck 1983). Fordi det er nøglen til støvpartikelspredelsen i området. Endvidere vil den åbne mine blive dybere med årene. Hvordan vil den påvirke vindforholdene i Narsap Ilua?

6. Vi kræver, at man bruger et andet støvpartikelemissionsprogram, som vil vise spredning af støvpartikler mere nøjagtigt (Sairanen 2018). Viden er nu, at støvpartiklerne er i luften i meget lang tid og når store afstande. (González, 2018)

7. Følsomme receptores placering af Orbicon var usystematisk. Derfor kræver vi at de lægges systematisk, som man gjorde i Denver. Og deres placeringer skal også tage højde for vores vandforsyningsarealer og for Narsaq by. (Se billede 7).

8. Vindhastigheder og vindretninger skal laves, hvor man tager højde for frostperioder og dagtimer (se australske Vittrinite Pty Ltd's fremvisninger, billede 9 og billede 10). Til støvpartikel-spredningsanalysen skal man benytte flere forskellige højder: F.eks. 4 meter, 6 meter og 8 meter.



Billede 12. Vindstyrkes øges med højden.

9. I dag er det snart 10 år siden, at man undersøgte vejrforholdene. Og der er sket ændringer i vejrforholdene. Vi kræver, at man laver ny undersøgelse af vejrforholdene i Kvanefjeldsområde.

10. Forskning af luftpartiklerne PM_{10} , $PM_{2,5}$ og $PM_{1,0}$ er blevet prioriteret mere og mere på nuværende tidspunkt. Vi opfordrer, at Namminersorlutik Oqartussat følger nøje med forskningen, fordi viden omkring dem bliver hele tiden opdateret.

11. Vi kræver på det kraftigste på ny, at Narsaq-indbyggerne skal sundhedsundersøges af uvildige læger. Og disse sundhedsundersøgelser vil pege på forværringer på folkesundheden i Narsaq i fremtiden.



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Particulate matter (dust particulate):

Classification of TSP (total suspended particulate): PM₁₀, PM_{2.5} and PM_{1.0}:

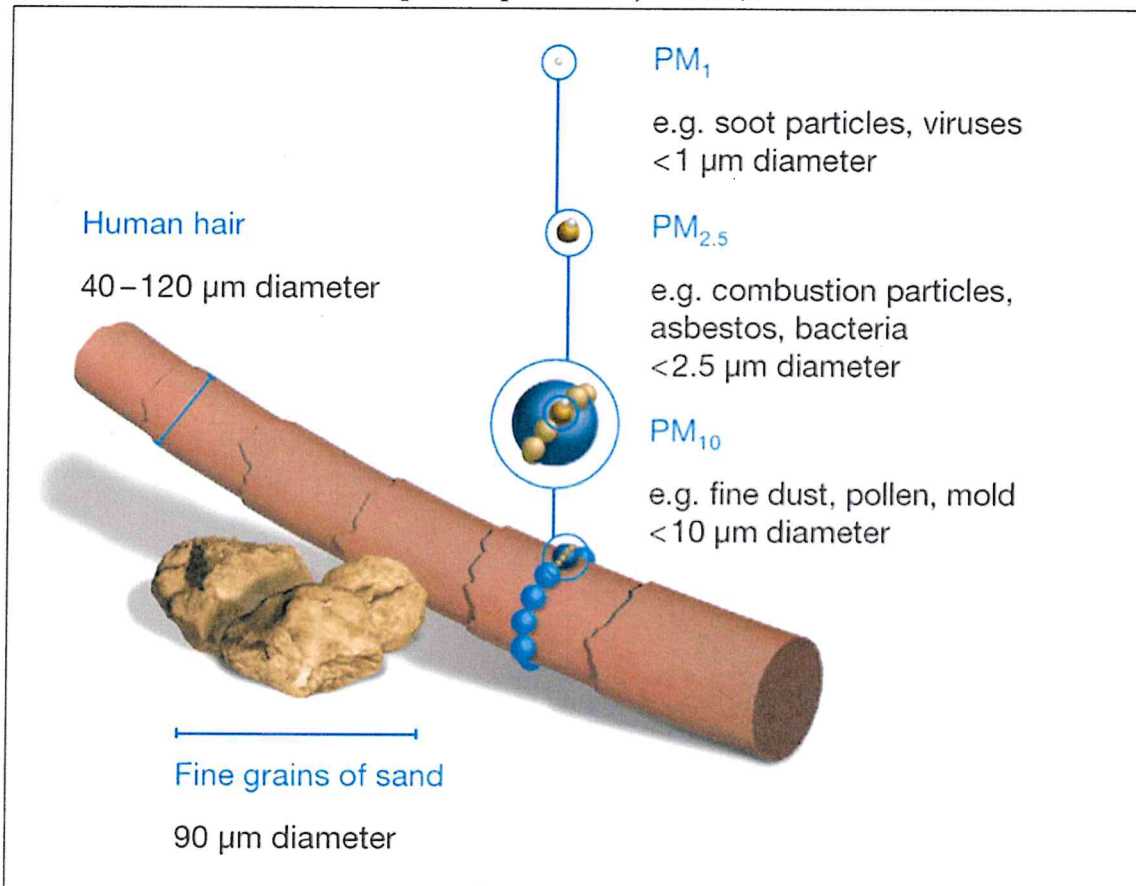


Figure 1. Illustration of particulate matter: PM₁₀, PM_{2.5} and PM_{1.0}.¹

TSP refers to all particulate matter (dust) with a diameter of less than or equal to 40 µm (microns), which can be felt with the tongue when it enters the mouth. PM₁₀'s diameter is less than or equal to 10 µm and it can be felt with the fingertips as extremely fine dust. The diameter of PM_{2.5} is less than or equal to 2.5 µm and it can be accurately felt with the fingertips as extremely fine dust particles. The diameter of PM_{1.0} is less than or equal to 1 µm and it is so small that it cannot be seen or felt.²

When you blast rocks, for example, in an open-pit mine, the smallest dust particles rise the highest in the dust cloud.

PM₁₀, PM_{2.5} and PM_{1.0} are inhalable and enter the human body through the respiratory tract, and they are harmful to human health because they have a larger surface area than larger particles. If you smash a bowling ball, you will have many fragments and a larger total surface area. The smaller the dust particles, the more dangerous they are. For example, if we compare 10 grams of TSP to 10 grams of PM_{2.5}, we find that the PM_{2.5} is far more hazardous than the equivalent amount of TSP due to its larger surface area.

¹ Air Particulate Monitoring – PM₁, Kruti Davda (2020), <https://oizom.com/knowledgege-bank/air-particulate-monitoring/>

² National ambient air quality objectives for particulate matter, Health Canada, Environment Canada (1998)



Urani? Naamik

Peqatigiiffik Narsaq Hearing about Kuannersuit-project 2020-2021

PM_{2.5} and PM_{1.0} dust particles are so small that they can enter the human body through the hair roots and skin.³ And this allows them to spread throughout the body via the blood circulation.⁴

Airborne dust particles (particulate matter)

Table 1: Comparison of the basic properties of fine vs course PM.

Characteristics	Fine fraction (PM _{2.5})	Coarse fraction (PM ₁₀)
Composition	Sulphate SO ₂₋₄ , nitrate NO ₃ , ammonium NH ₄ , hydrogen ion H ⁺ , elemental carbon C, organic compounds, PAH metals Pb, Cd, V, Ni, Cu, Zn, particle-bound water, biogenic organics.	Resuspended dust, soil and street dust, coal and oil fly ash, metal oxides of Si, Al, Mg, Ti, Fe, CaCO ₃ , NaCl, sea salt, pollen, mold spores, plant parts.
Sources	Combustion of coal, oil, gasoline, transformation products of NO _x , SO ₂ , and organic including biogenic organics, high temperature processes, smelters, and steel mills.	Resuspension of soil tracked onto roads and streets, suspension from disturbed soils, resuspension of industrial dust, construction, coal and oil combustion, and ocean spray.
Lifetimes	Days to weeks	Minutes to hours
Travel distance (km)	100 to 1000	1 to 10

Table 1.⁵ NB! PM_{1.0} is not included in the table because it is currently the subject of ongoing additional research. But it can be assumed that it is dispersed much farther than larger particulate matter.

Particulate matter is so small that it can become airborne where it enters water particles (water vapor). And it remains in the air for a long time, drifting with the wind and traveling extremely long distances.

The impact of dust on human health

Research into the impact of dust particles on human health has intensified over the past decade. Many countries have established air quality criteria for their civilian populations. Criteria have been introduced for TSP, PM₁₀ and PM_{2.5}. But not yet for PM_{1.0}. However, there is no doubt that criteria for PM_{1.0} will come soon – hopefully very soon – because of the danger that it poses to human health.

European researchers estimate that 630,000 premature deaths in the EU were attributable to environmental factors in 2012, with air pollution accounting for approximately 400,000 deaths annually.⁶

³ Impact of airborne particulate matter on skin: a systematic review from epidemiology to in vitro studies, Irini M. Dijkhoff et al. (2020)

⁴ Effects of Inhalable Particulate Matter on Blood Coagulation, Matteo Bonzini et al. (2010)

⁵ Dust production in mining. Suppression measures in quarry blasting, Gonzalo Morera De La Vall González (2018)

⁶ Healthy environment, healthy lives: how the environment influences health and well-being in Europe, European Environment Agency (2020)



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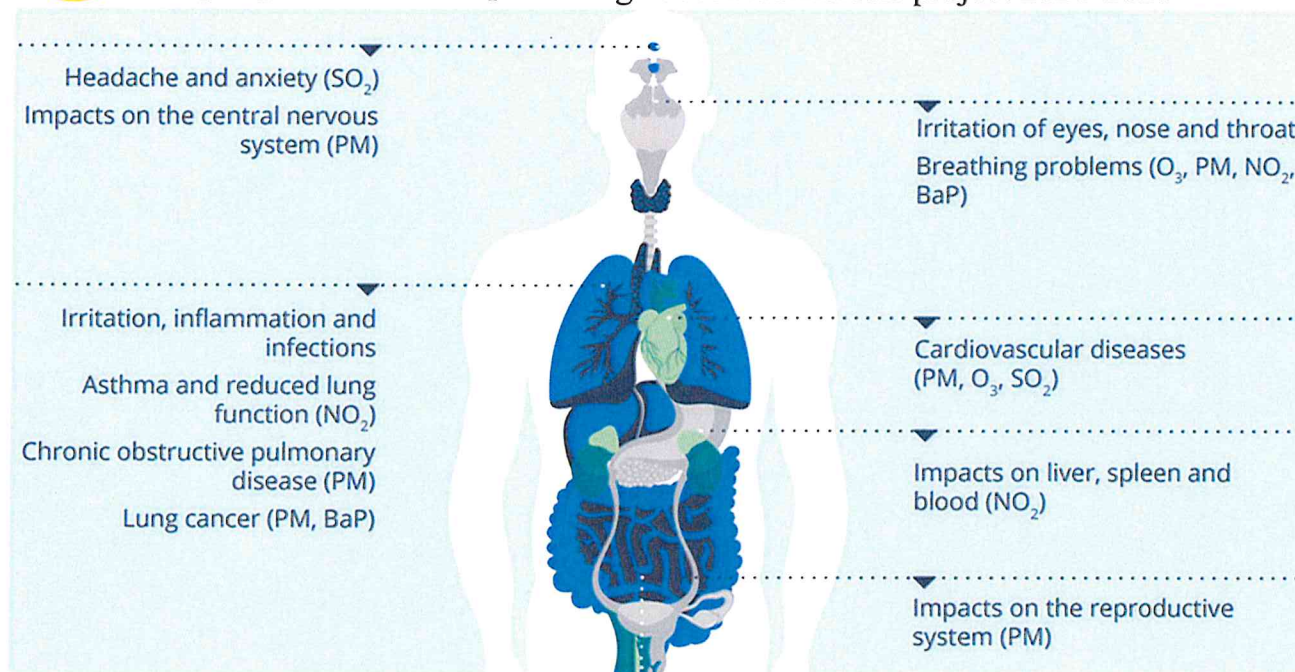


Figure 2. Potential impact of ambient air pollution on human health ⁷

Elements and minerals, most of which are heavy metals:

Elements that are radioactive and their isotopes in Kvanefjeld:

Uranium, thorium, radium, actinium, radon, polonium, bismuth, lead, thallium, beryllium, protactinium, cerium, hafnium, manganese, niobium, tantalum, francium, astatine, neptunium and strontium.⁸

Rare-earth elements (REE):

Lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium, yttrium and scandium.⁹

Heavy metals:

Lead, barium, arsenic, mercury, zinc, iron, aluminum, chromium, silicon, rubidium, selenium, vanadium and cobalt and others.¹⁰

All in all, over 200 different minerals are present in the Ilimmaasaq Complex.

“The vulnerability of children to environmental stressors. Children are more vulnerable than adults to environmental risks. First, they breathe more air, consume more food and drink more water than adults in proportion to their weight. Second, the central nervous, immune, reproductive, endocrine and digestive systems of a child are still developing. During certain critical windows of vulnerability, exposure to environmental contaminants can lead to irreversible damage.

Third, children behave differently from adults and have different patterns of exposure to environmental hazards. Young children crawl on the ground and can therefore be exposed to dust

⁷ Healthy environment, healthy lives: how the environment influences health and well-being in Europe, European Environment Agency (2020)

⁸ The emplacement and crystallization of the U–Th–REE-rich agpaitic and hyperagpaitic lujavrites at Kvanefjeld, Ilímaussaq alkaline complex, South Greenland, Henning Sørensen et al. (2011)

⁹ The emplacement and crystallization of the U–Th–REE-rich agpaitic and hyperagpaitic lujavrites at Kvanefjeld, Ilímaussaq alkaline complex, South Greenland, Henning Sørensen et al. (2011)

¹⁰ The emplacement and crystallization of the U–Th–REE-rich agpaitic and hyperagpaitic lujavrites at Kvanefjeld, Ilímaussaq alkaline complex, South Greenland, Henning Sørensen et al. (2011)



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and chemicals that accumulate on floors and soils. Finally, children have little control over their environments. Unlike adults, they may be both unaware of risks and unable to make choices to protect their health. Because of these unique vulnerabilities, children need special protection from environmental hazards.”

Source: WHO (2017c).¹¹

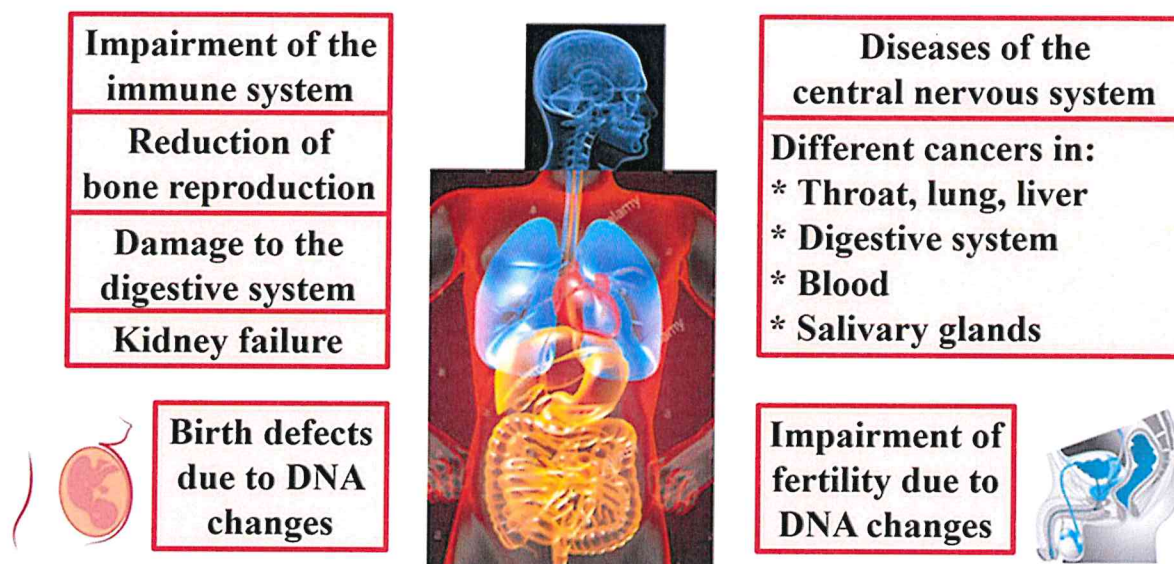


Figure 3. The impact of radioactive elements and their isotopes on the body.¹²

And we should mention that the EIA report does not mention beryllium disease, which affects miners and the general civilian population.

Blasting of rocks at Kvanefjeld

The plan is to blast 6,000,000 tons of rock at the Kvanefjeld mining project every year. And blasting will take place every other day, in other words at least 180 blasts per year. On average, 33,333 tonnes of rock will be blasted each time. This is the equivalent of 12,400 cubic meters of rock.¹³



Figure 4. Each blasting operation corresponds to the size of Narsaq's football field and a depth of 2 meters. 96 x 65 x 2 meters.

¹¹ Healthy environment, healthy lives: how the environment influences health and well-being in Europe, European Environment Agency (2020)

¹² Uranium mining and health, Canadian Family Physician • Le Médecin de famille canadien, Dale Dewar et al. (2013)

¹³ Kvanefjeld Project Environmental Impact Assessment, Greenland Minerals limited 2020.



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Figure 5. Open-pit blasting and dispersal of dust particles.

Particulate matter from the Kvanefjeld project in Narsaq

The following activities in the Kvanefjeld project will generate particulate matter: ¹⁴

1. Construction
2. Drilling
3. Blasting
4. Transport to the waste rock storage facility and the ore crusher
5. Discharge of tailings to the waste rock storage facility and the ore crusher
6. Crushing of ore
7. Loading of ore fine powder
8. Hauling to the port
9. Loading of ships
10. Exhaust from ships
11. Transportation toward the mining area
12. Exhaust from vehicles
13. Exhaust from the power plant

And one would expect accidents to occur during transportation, as well as during the loading and unloading of ore.

The EIA and SIA reports did not mention how hazardous particulate matter is, nor the most hazardous categories, namely $PM_{2.5}$ and $PM_{1.0}$. ¹⁵

Calculating dust emissions with the CALPUFF modeling system

CALPUFF is a computational modeling program for predicting atmospheric pollution dispersion. Particulate matter emissions are based on a height of 2 meters. ¹⁶ CALPUFF has been tested and it has been concluded that it is better at predicting where distances exceed 50 km. But its particulate matter emission predictions are often too low compared to the actual situation on the ground. ¹⁷

¹⁴ Air Quality Assessment – Kvanefjeld, ERM Worldwide Group Ltd (2018)

¹⁵ Kvanefjeld Project Environmental Impact Assessment, Greenland Minerals limited 2020.

¹⁶ Air Quality Assessment – Kvanefjeld, ERM Worldwide Group Ltd (2018)

¹⁷ Performance evaluation of AERMOD, CALPUFF, and legacy air dispersion models using the Winter Validation Tracer Study dataset, Arthur S. Rood (2014)



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Dispersion model of particulate matter from the Kvanefjeld project in Narsaq:

The EIA & SIA reports use the EPA's¹⁸ method for calculating dust dispersion (gray box): ☐
1 kg particulate matter:

Table 2	TSP	PM ₁₀	PM _{2.5}	PM _{1.0}	Respirable
Ratio	1	34.1 % of TSP	29.5 % of PM ₁₀	-	
Grams	1000	341	101	-	minimum 341

Table 2: According to the EPA's dispersion model for particulate matter from mining operations.

CALPUFF's projected particulate matter emissions are based on wind measurements at the top of Kvanefjeld during the period 2010-2014, and the EIA & SIA reports conclude that particulate matter from the project will not be hazardous to the health of the civilian population in Narsaq and the surrounding area.¹⁹

The EPA's PM_{2.5}, PM₁₀ and TSP benchmarks have been reviewed based on 25 studies of different mines around the world. And the authors of the studies note that dust pollution increases with the length of mining operations. (Saironen 2018)

According to Saironen (2018),²⁰ the dispersion model for PM_{2.5}, PM₁₀ and TSP should be different, and when combined with Sun's studies with PM_{1.0},²¹ we obtain an entirely different picture of the particulate matter dispersion in the Kvanefjeld project (yellow background): ☐

Table 3	TSP	PM ₁₀	PM _{2.5}	PM _{1.0}	Respirable
Ratio	1	34.1 % of TSP	29.5 % of PM ₁₀	-	
Grams	1000	341	101	-	minimum 341
Ratio	1	55.6 % of TSP	37.0 % of PM ₁₀	70.0 % of PM _{2.5}	
Grams	1000	556	185	130	minimum 556
Difference		215	84	130	215

Table 3: Calculation based on 1 kg of particulate matter.

¹⁸ Air Quality Assessment – Kvanefjeld, ERM Worldwide Group Ltd (2018)

¹⁹ Air Quality Assessment – Kvanefjeld, ERM Worldwide Group Ltd (2018)

²⁰ A review of dust emission dispersions in rock aggregate and natural stone quarries, Marjo Sairanen et al. (2018)

²¹ Chemical Differences Between PM₁ and PM_{2.5} in Highly Polluted Environment and Implications in Air Pollution Studies, Yele Sun et al. (2020)



Additional arguments

The town of Narsaq is located close to Kvanefjeld. The distance is 5-6 km. To calculate emissions dust particles, sensitive receptors have been placed in area surrounding Narsaq:

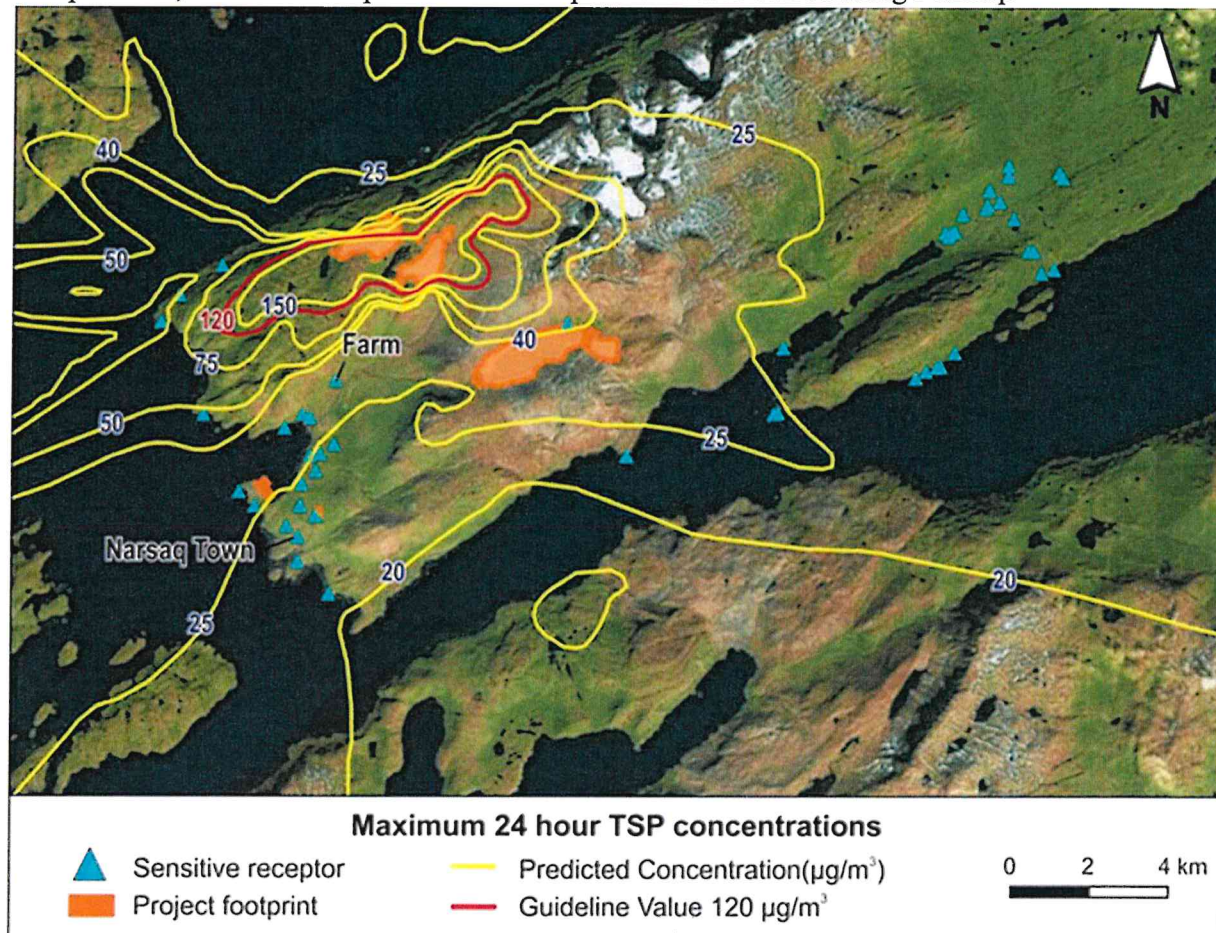


Figure 44 The maximum 24-hours TSP concentrations in $\mu\text{g}/\text{m}^3$ (cumulative)

Figure 6. Note the locations of sensitive receptors.²²

Priority has been given to protecting certain sites:

- Four locations in Narsaq
- The farm in the Narsaq Valley
- Five summer cottages in the Narsaq Valley
- The proposed location of a workers' village
- 45 archaeological sites and
- the habitat of the vulnerable round-leaved orchid (*Amerorchis rotundifolia*).

²² Kvanefjeld Project Environmental Impact Assessment, Greenland Minerals limited 2020.



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In Denver, USA, sensitive receptors were placed in a systematic manner. (See Figure 7).

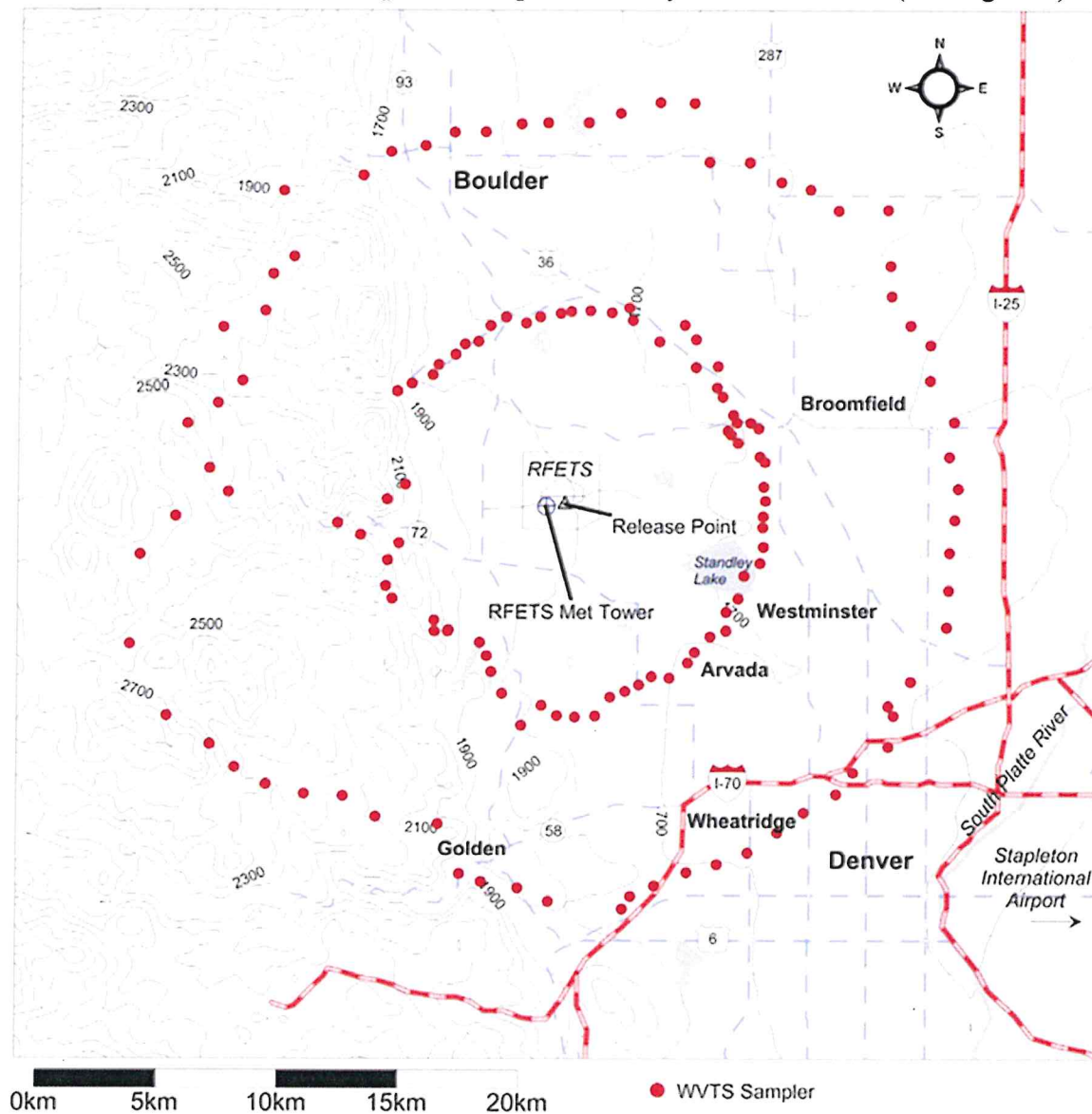


Fig. 1. CALPUFF model domain showing location of the WVTS samplers and terrain features of the Colorado Front Range.

Figure 7. From: *Performance evaluation of AERMOD, CALPUFF, and legacy air dispersion models using the Winter Validation Tracer Study dataset* Arthur S. Rood 2013-14



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The EIA and SIA reports show the weather conditions in the years 2010-2014 from one unmanned weather station, which was located on top of the Kvanefjeld. Distance to the town of Narsaq 5-6 km:

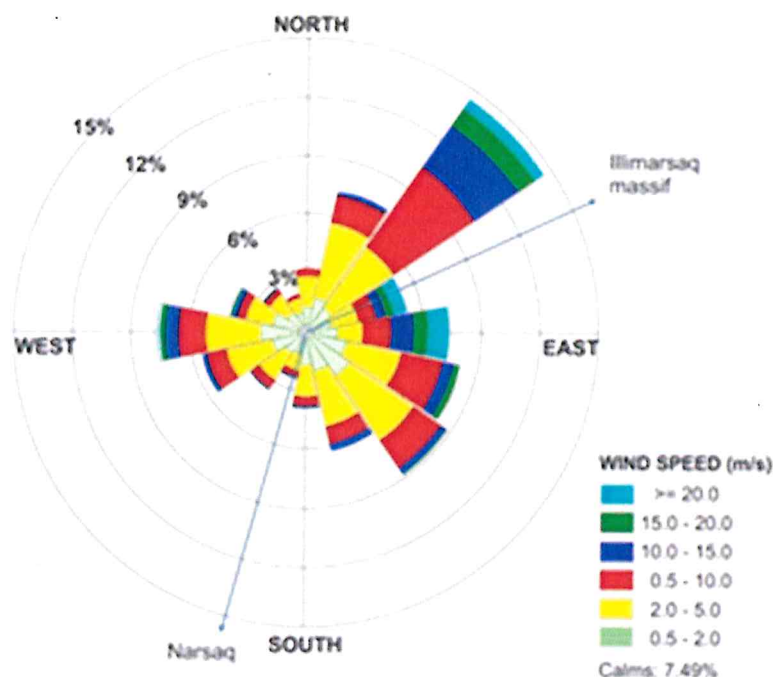
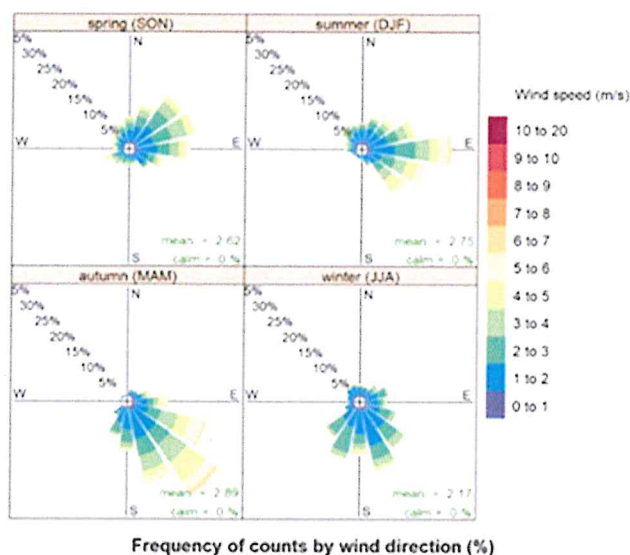


Figure 35 Wind directions and speed recorded from Kvanefjeld weather station

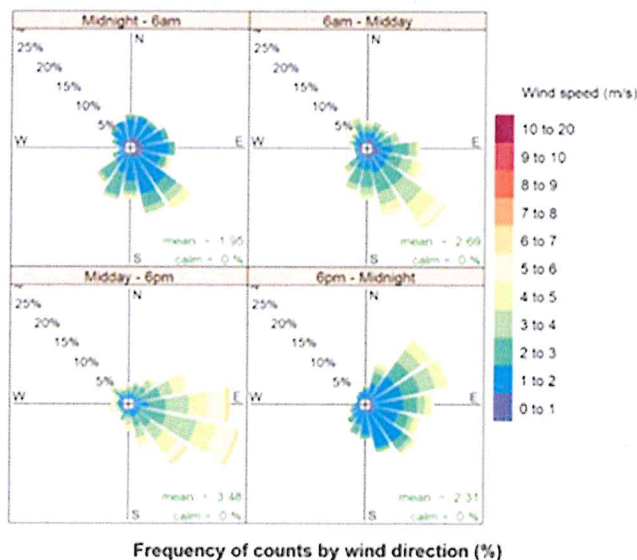
Figure 8. Average wind directions and wind speeds at Kvanefjeld 2010-2014.

In Australia, Vitrinite Pty Ltd applied to open a coal mine.²³ And they meticulously produced graphs of wind directions and wind speeds because the proposed coal mine would be located between two towns: Moranbah with 9,000 inhabitants, which is 30 km south of the proposed coal mine project and Dysart with 3,000 inhabitants, which is 35 km from the proposed site.



Seasonal wind roses for the VCP site (extracted from CALMET) – 2018

Figure 9. Seasonal analysis.



Diurnal wind roses for the VCP site (extracted from CALMET) - 2018

Figure 10. Diurnal analysis

²³ Vulcan Complex Project Air Quality Assessment, Simon Welchman (2020)



Along the mountain slopes of Narsap Ilua, it is shown that dust particle emissions will be blown upwards toward the Kvanefjeld project.

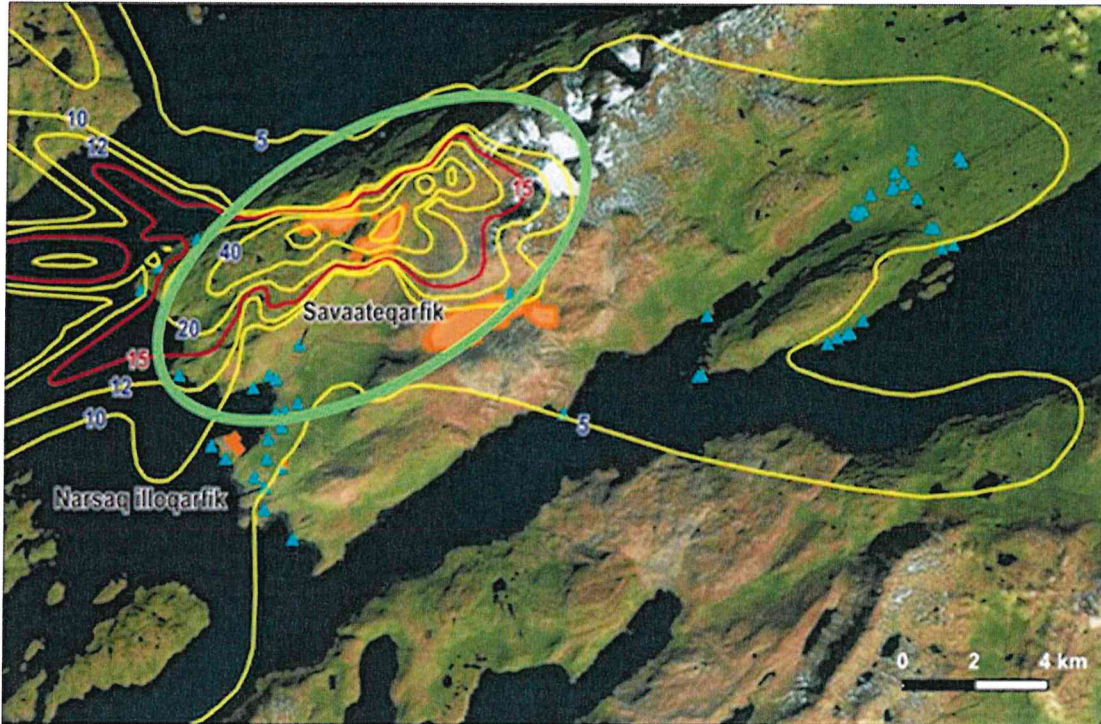


Figure 11. Note: The wind blows upwards along the mountain slopes.

Gryning and Lyck made meteorological observations in Narsap Ilua in 1983. They were puzzled by drainage winds in winter. The drainage winds blew down the mountain slopes. And in Narsaq these sudden gusts of wind are called “aqqarsarnek,” i.e. “downward wind”. The other thing they noticed is that the wind in the valley changes direction by 180° every half hour.²⁴

According to the EIA and SIA reports, the dispersion of dust particles will be reduced by using “fog cannon” during the summer. They don’t expect to completely eliminate all dispersion. In cold weather, the dust cannot be suppressed with fog cannon.²⁵

²⁴ Preliminary Environmental Impact Statement for the Kvanefjeld Uranium Mine, Kim Pilegaard (1990)

²⁵ Kvanefjeld Project Environmental Impact Assessment, Greenland Minerals limited 2020.



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We strongly demand that:

- The reason for our most strident demands is that the Kuannersuit (Kvanefjeld) is located close to towns, sheep farms, reindeer herding farms, cattle farms, horticulture, pastures, grazing areas for breeding animals and fishing and fishing grounds (see Table 1). Dust particle pollution will affect all living creatures and have a negative impact on their health: the civil population, animals, birds, fish, insects and plants. And it will destroy the interplay between living organisms, that is to say the entire biodiversity.

Weather patterns have changed since 2010-2014. Due to climate change, there are more powerful storms. During the winter, we have strong northerly winds, especially following piteraq storms in East Greenland. During the summer, there are often westerly winds.

1. New findings about particulate matter have recently emerged. We therefore demand that the ratios 1 : 0.556 : 0.185 : 0.130 for TSP : PM₁₀ : PM_{2.5} : PM_{1.0} be used for a new dust emission calculation based on Sairanen's (2018) and Sun's studies (Sun 2020). Furthermore, we demand that the air quality in Narsaq town be studied because current levels of airborne particulate matter from day-to-day activities in town must be added to the levels of particulate matter generated from mining activities.

2. We strongly demand that the composition of dust elements and their isotopes be analyzed and made public because most of the elements are heavy metals that cannot be broken down and are very harmful to health:

20 radioactive elements and their isotopes:

Uranium, thorium, radium, actinium, radon, polonium, bismuth, thallium, beryllium, protactinium, cerium, hafnium, manganese, niobium, tantalum, francium, astat, neptunium and strontium.

Rare-earth elements (REE):

Lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium, yttrium and scandium.

Other elements:

Fluoride, lead, barium, arsenic, mercury, zinc, iron, aluminum, chromium, silicon, rubidium, selenium, vanadium, cobalt and other elements and minerals, all told more than 200.

3. Other dust experts should examine "Air Quality Assessment - Kvanefjeld, ERM Worldwide Group Ltd (2018)", for their predictions of particulate matter levels associated with the Kvanefjeld project.

4. We demand information on bore hole sizes and bore hole depths because this is important information for determining how high the dust particles rise into the air during blasting.²⁶

5. We demand that the micrometeorology of the Narsap Ilua (Dyrnæs) valley be investigated (Gryning and Lyck 1983) because this is the key to dust particle dispersion in the area. Furthermore, the open pit mine will become deeper over the years. How will this affect the wind conditions in Narsap Ilua?

²⁶ Sikkerhedsanvisninger ved sprængningsarbejder, DSF (2017)



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6. We demand the use of a different dust emission dispersion program, which will provide more accurate predictions of dust particle dispersion (Sairanen 2018). It is now known that the dust particles remain airborne for a very long time and travel great distances. (González, 2018)

7. The placement of sensitive receptors by Orbicon was unsystematic. We therefore demand that they be placed in a systematic manner, as was done in Denver. And their placements must also take into account our water supply areas and the town of Narsaq. (See Figure 7).

8. Predicted wind speeds and directions must take into account seasonal variations (winter and summer) and the times of the day (see Australian Vitrinite Pty Ltd's projections, (Figure 9 and Figure 10). Several different heights must be used for the dust particle dispersion analysis: E.g. 4 meters, 6 meters and 8 meters.

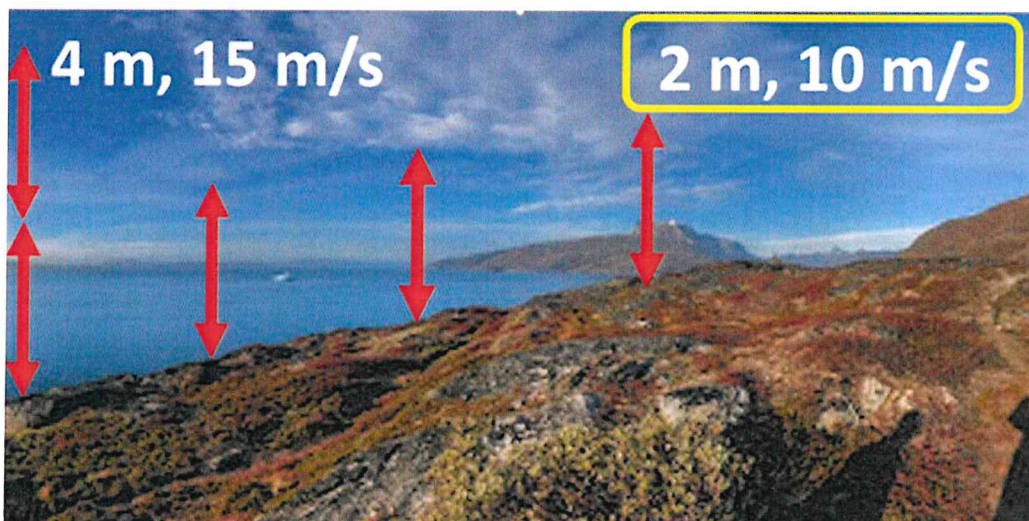


Figure 12. Wind speeds increase with height.

9. It has now been almost 10 years since the weather conditions were studied. In the meantime, weather conditions have changed. We demand a new study of the weather conditions in the Kvanefjeld area.

10. Research on the air particles PM_{10} , $PM_{2.5}$ and $PM_{1.0}$ has been prioritized more and more at present. We demand that Namminersorlutik Oqartussat closely follow the research because knowledge about them is constantly updated. (googletranslat)

11. We strongly reiterate our demand that Narsaq residents undergo health checks by independent doctors. And these health studies will indicate worsening public health in Narsaq in the future.

Thank to Paul Cohen (text@cohen.gl, www.cohen.gl) , who translat this article from danish to English.



Najoqqatarineqartut/reference/references:

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3. Effects of Inhalable Particulate Matter on Blood Coagulation, Matteo Bonzini allallu (2010)
4. Uranium mining and health, Canadian Family Physician • Le Médecin de famille canadien, Dale Dewar allallu (2013)
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Urani? Naamik Peqatigiiffik Narsaq

Narsaq 11.august 2021

Urani? Naamik Peqatigiiffik Narsaq nutaanik siulersuisortarpoq.

Urani? Naamik Peqatigiiffik Narsaq har fået en ny bestyrelse.

Urani? Naamik Peqatigiiffik Narsaq 5.august 2021 ileqquusumik ataatsimeersuarnermini nutaanik siulersuisortarpoq.

Urani? Naamik Peqatigiiffik Narsaq holdte ordinær generalforsamling 5.august 2021, og valgte ny bestyrelse.

Jan Rehtmar-Petersen
Siulittaasoq / Formand

Niels Sakariassen
Siulittaasup tullia / Næstformand

Grethe G. Nielsen
Angingaaserisoq allatsi /

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